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Insular monument building : a cause of social stress? The case of prehistoric Malta.

INSULAR MONUMENT BUILDING: A CAUSE OF SOCIAL STRESS?

THE CASE OF PREHISTORIC MALTA

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ABSTRACT

Prehistoric monument building, particularly that on islands, is reviewed. The insularity and nature of island societies and the question of possible social stress arising from these activities is posed. The degree of stress must be quantified and the technique of energetics analysis is the best available.

Prehistoric Malta is chosen for detailed examination of these questions. The island is first described, including its location, geography, geology, climate and extant remains, together with the cultural phases and possible structure of its society. The rationale of an energetics analysis is covered with several examples of its application and a justification of its utility for Malta.

The Ggantija temple is chosen for particular study and detailed drawings of its remains are given. The architecture of the original temple is hypothesised and the materials involved quantified. For each material the unit labour costs of procurement (including the location of sources), transport, preparation and construction are estimated. By combining the quantities of materials used with the unit labour costs, the total labour requirements are computed. A sensitivity analysis, allowing for significant variation of all the important figures, is given. Previous work on labour requirements is reviewed and found to be a grave over-estimate.

The prehistoric population numbers, and the availability of temple building workers, is estimated. Combinations of the figures for labour required and labour available allows estimates of the percentage demand on worker's time to be made, including a sensitivity analysis. These percentages give a quantified view of the stress which temple building placed on society.

Contrary to previous suggestions embedded in the literature, no excessive stress is indicated. Further, there is no evidence of any concentration of building effort at the end of the period and it is unlikely that temple construction per se contributed to that culture's downfall.

These are major conclusions and justify the use of energetics analysis and the work involved.

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AUTHOR'S DECLARATION

I declare that the work in this dissertation was carried out in accordance with the Regulations of the University of Bristol. The work is original except where indicated by special reference in the text and no part of the dissertation has been submitted for any other degree.

Any views expressed in the dissertation are those of the author and in no way represent those of the University of Bristol.

The dissertation has not been presented to any other University for examination either in the United Kingdom or overseas.

Signed: Daniel Clark ....

Date: 5 June 1999 ....

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CHAPTER 1

UNIQUE ISLAND DEVELOPMENTS

1.1 INTRODUCTION

The title of this thesis is "Insular Monument Building: a cause of social stress? The case of prehistoric Malta". The broad elements that need to be reviewed are:

1. What constitutes an island and defines insularity?

2. What constitutes a monument? Are island monuments unique to the islands on which they stand?

3. What was the structure of the societies that built monuments and did this change over time?

4. Did building monuments cause social stress, and was such stress particularly acute for small island societies? How is stress to be measured?

In this chapter each of these elements is considered in turn, followed by a review of a number of prehistoric island societies which built monuments and which may be instructive in considering the case of prehistoric Malta, consideration of which starts in Chapter 2.

Finally, there is a brief introduction to the methodological approach adopted: that of energetics analysis.

1.2 WHAT CONSTITUTES AN ISLAND AND DEFINES INSULARITY?

Chambers Twentieth Century Dictionary defines an island as "a mass of land surrounded with water - - - anything isolated, detached, or surrounded by something of a different nature, eg. a wood among prairies - - -". Making a social point John Donne (c.1571-1631) wrote: "No man is an island, entire of itself". (Devotions). The sentiment is equally relevant to our purposes.

Some islands are so large that from the perspective of an examination of specialised island cultures, they should in fact be regarded as continents, where heterogeneous societies can develop. Australia is an obvious example. Veth (1993) considered one such development in "*Islands in the Interior*" which reports on an isolated society surrounded by the desert of northwest Australia.

In the case of islands bounded by the sea, their populations depended for contact beyond their shores on purposeful journeys by sea, to or from their island. At the same time there are what might be called degrees of insularity or boundedness. To what extent, after initial colonisation, did populations maintain previous living systems and beliefs, and to what extent did adaptations to new insular conditions produce new modes? To what extent were such adaptations influenced by contact with populations beyond the sea, populations who were themselves developing? There are two elements to be considered. The first and easier is geographic location. The further a particular island is from the nearest land, the greater its boundedness is likely to have been, and conversely the closer to the nearest land the less the boundedness dictated by geography. Easter Island is an obvious example of the former, lying 2250km from the next nearest island, and so small that it is remarkable it was ever found and colonised at all in prehistoric terms. At the other extreme, Purcell (1995) in reviewing the detailed publication of an Aegean island survey by Cherry, Davis and Mantzourani (1991) criticised those authors for not sufficiently recognising the unboundedness of the island of Keos, situated less than 15km from mainland Greece. He avers that their analysis took insufficient account of the island's many links with the mainland: indeed that seaborne traffic enhanced these links compared to overland links over similar distances. Not only will the location of a particular island affect the continuing contact its population has with its neighbours, it will also affect the likelihood of further waves of immigration after initial colonisation. Once again, this was unlikely in the case of Easter Island, but the location of all the islands in the Mediterranean (including Malta) meant that there was no physical bar to such further waves.

Linking the first element of boundedness, that of geography, with the second, that of the island population's attitude to boundedness, is whether the island's location placed it in such a position as to be a desirable staging post in trade between other, off shore, communities. The Balearics, for example, were not on a trading route. Malta on the other hand, certainly from Phoenician times but perhaps not before, was on such a route between the eastern and western Mediterranean basins (a point discussed further in Chapter 9).

The second element of boundedness to be considered is each island population's attitude to it, and how such attitudes may have changed over time. These attitudes were partly determined by necessity – for example for essential commodities not available on the island in question – and with "will", did the society in question want to maintain contact with the world beyond them or not? In the case of the Aegean islands in general, which had no obsidian, contact with Melos was essential in order to obtain this prerequisite for tool manufacture. The same applies to the Maltese islands, which obtained their obsidian from the Lipari islands or from Pantellaria. But beyond the obtaining of such necessities, how bounded were islands? The answer must be that boundedness varied from island to island, and also over time.

That the means of transport was not an element in the degree of an island's boundedness is clear. Seaborne transport in antiquity is well attested, although in the Mediterranean, as elsewhere, it might have been limited to certain times of the year. Obsidian from the Aegean island of Melos, dating to about 10,000 BC, was found on the mainland of Greece at Franchthi cave. The colonisation of the Maltese islands took place about 5000 BC. This post dated, for example, Crete in the late eighth or early seventh millennium, but much preceded, in the western Mediterranean, that of the Balearics in the third millennium BC. Other examples might be cited, but it is clear that sea crossings took place in the Mesolithic and were well within the competence of Neolithic cultures.

To what extent the first colonisation was followed by further contact is an important question in relation to cultural development. Further contact might take any of three forms: further wave/s of colonisation, procurement of essential commodities, and trade. The first form needs no further comment except to say that further wave/s of colonisation, whether from the same area as the preceding, or elsewhere, could bring new cultural elements. The second, although sometimes confused with the third, stands on its own: those in need of Melian obsidian, for example, could sail to get it without anything being given in return to the occupants of Melos (when there were any). Indeed, for 6000 years, from the tenth to the fourth millennium BC, there were no permanent settlements on Melos (Bahn: 1992). Trade implies a mutual interest in one community providing something wanted by a second, in return for the second providing something wanted by the first. "No man is an Island" and all three of these forms of further contact, after initial colonisation, could spread cultural influences in either direction.

It is sometimes difficult to distinguish between the second and third forms, particularly because the material moving in one direction may be archaeologically durable, whereas that moving in the other has perished. For example, eastern Mediterranean spondylus shells, or the ornamental beads made from them, are found as far west as Holland, in Neolithic contexts (Phillips 1980 : 170). What was the trade mechanism? Did the 'Dutch' go and fetch them? Did eastern Mediterraneans bring them, and if so, with what return? Or were they passed from hand to hand, increasing in value as they went? And if so, again with what return? A further instance occurs in Maltese prehistory: the Maltese needed obsidian and obtained it from Lipari and from Pantelleria (Cann and Renfrew 1964 : 120); what had they to offer in exchange? Or was there no need because an expedition could be sent to obtain obsidian from one of the islands above, as was certainly the case in the earlier Melian period? Discussion of the Maltese use of obsidian brings us to a further point concerning boundedness, namely whether fluctuations in imports or trade over time may have taken place and if so, why. In Malta there are signs of a diminution of imports at the start of the temple building period and a resumption in the Tarxien Cemetery phase. (Malone and colleagues 1993 : 83; Stoddart and colleagues 1993 : 7 and 17). This situation will be discussed further in the next chapter. On the Balearics, a similar phenomenon is noted by Patton (1996 : 96) with a decline in "the significance of trade" in the Talayotic monument building period followed by a resumption in the post-Talayotic period. All these authors suggest the decline is associated with a change from an exchange-oriented society to a monument-oriented society, followed by a reversal of this position. Clearly, such a proposition is important in relation to the motivation for monument building, and the degree of isolation, or insular boundedness involved; and also to the question of stress.

1.3 WHAT CONSTITUTES A MONUMENT? WHERE ARE THEY FOUND? ARE THEY UNIQUE TO THE SOCIETIES THAT BUILT THEM?

The word "monument" has a wide variety of meanings. The sense in which it is used in this thesis is the narrow one of "a notable building or site" (one of several meanings given in Collins English Dictionary). They are found in both island and mainland settings. To cite a few, there are Ahu and statues on Easter Island; navetas, talyots and taulas on the Balearic islands; nuraghi on Sardinia; temples and hypogea on the Maltese islands; and 'palaces' on Crete. Mainland sites include temples in Mesopotamia; pyramids in Egypt and megalithic constructions in western Europe. Conversely there are islands with no such monuments – Cyprus and Sicily for example – and mainland areas also with none, southern Italy for example. Whatever the social motivation for monument building, it is clear that such motivation did not apply to all societies, nor indeed to any given society for all time.

Where monuments are found, they are usually unique to the society that built them. In all the examples noted above, there are no analogues elsewhere. In relation to island monuments Evans (1973 : 519) has this to say: "Island communities often display a tendency towards the exaggerated development of some aspect of their culture, which is often connected with ceremonial. The isolation and relative security (and perhaps boredom) of island life can allow the continuance of trends which in a mainland environment are likely to be inhibited by various extraneous factors long before they can reach their logical conclusion. Particular biases then show up which may continue to become progressively more developed over a long period of uninterrupted community life. It is, for instance, a striking fact that a large number of island communities in many parts of the world have spent much time and energy in erecting extensive ceremonial and religious complexes, which they have gone on progressively elaborating and embellishing over a great many centuries". This quotation usefully leads to the next section.

1.4 WHAT WERE THE STRUCTURES OF THE SOCIETIES THAT BUILT MONUMENTS AND DID THESE CHANGE OVER TIME?

One of the themes that used to run through earlier literature concerning large monument construction was that they were built by state societies or by societies approaching statehood. It was thought that the monuments in question were so large that they would have required vast numbers of workmen to build them. The recruitment and organisation of such a workforce, together with planning the monuments, could only be achieved by a complex hierarchical society with coercive power at its command. Of the examples cited in section 1.3 above, it is clear that some monuments were built by fully developed state societies (Egypt, Mesopotamia, Crete). States are based on cities. Clark (1946 : 89) suggests that cities are: "the most palpable index of civilization". Cities were the centres of hierarchical societies, with concomitant inequality, drawing supplies from the surrounding countryside, involved in supporting non-farming specialists, and in general redistributing food and other requisites. The state elite would have, at its command, some form of militia which could be used not only in conflicts with neighbours, but also to secure its home power base. On the other hand some monument building societies did not have a state structure. Both Malta and Easter Island, because of their size, could not support a large enough population to reach statehood of the form outlined above. There is, however, no clear dividing line between pre-state and state societies. Much use has been made in the anthropological literature, and subsequently archaeological literature, of the pre-contact societies in the Pacific. In one of the most developed of the Polynesian cultures, that on the Hawaiian islands, the distinction between a complex chiefdom structure and a state structure, is not clear. This problem also exists in considering the structure of society in the Mayan lowlands of the Yucatan, Mexico, and is the subject of discussion in Chapter 3.

What can be said unequivocally is that a state structure has it in its power to conceive and execute monumental edifices. The motivation and organisation of pre-state societies to erect such monuments is less easily discerned.

In the 1970s archaeologists, in considering the organisation of pre-state societies, put much weight on anthropological work in the Pacific. The sequence was perceived as a progression: Bands→Tribes→Chiefdoms→States and sometimes portrayed as a ladder of progress up this sequence. But this portrayal has subsequently been recognised as too simplistic. In particular the structure of society in Tribes and Chiefdoms has been seen as capable of many different manifestations. Tribes were typically led by "Big Men", those who rose to leadership through personal competence or charisma. Chiefdoms institutionalised this process by emphasising the importance of genealogy or the relationship of the chief's family to the proposed or asserted closeness to the ancestral founder of the group.

At this point there should be some consideration of the roles of secular and religious authority. A secular authority is necessary in any society to adjudicate in inter-personal disputes over land or animals, or other matters that cause friction in society. At the same time people tend to look for a meaning to their lives beyond their immediate, everyday existence. What they find has an infinite variety. Places may be given a sacred ascription, ancestors may be sacred, gods with human or animal or hybrid forms may be sacred, living people may be sacred and so on, and there may be any combination of these. Envisioning and interpreting the wishes of the divine needs mediation and this tends to become institutionalised in some form of human mediator, who because of his/her office, exercises authority. Thus we have a role for both secular and religious authority. In all forms of society, examples may be found where one or other authority is predominant or where the two roles are combined. Where they are separate, there will tend to be tension between the two and the predominance of one or the other over time, may change.

In state societies, monuments may be built to reinforce religious or secular power or as individual self aggrandising personal monuments – mausolea of one kind or another – harnessing the power the state has to mobilise and organise the necessary expertise and labour. In pre-state societies, there may not be the necessary imperative to construct large monuments. Individual power of chiefs or their equivalent may be demonstrated by larger burial edifices and grander burial goods, but their power will not be adequate to muster the labour to build large, purely secular monuments to an individual. Religious authority may be in a position to muster sufficient communal enthusiasm to erect large monuments as a means of contacting the divinities with a view to placating them and or seeking their intercession on humanity's behalf.

But it is difficult to find an example of this happening without there being some additional impetus. Human populations tend to grow to the point where some constraint hinders or prevents further growth. This gives rise to rivalries between adjacent human groups. Territory becomes important and the groups find it desirable to stake a claim to their particular territory and ideology and to declare their equality with, if not superiority to, neighbouring groups. This situation can give rise to the necessary additional impetus. It is to this situation that most archaeologists and anthropologists would attribute most pre-state monumental building.

In pursuing the study of cultural change, therefore, it is necessary to ascertain whether such rivalries might have existed and been causal in the erection of large monuments: Do the form and location of monuments indicate such rivalries?

Following this line of enquiry brings us to the final questions:

1.5 DID BUILDING MONUMENTS CAUSE SOCIAL STRESS, AND WAS SUCH STRESS PARTICULARLY ACUTE FOR SMALL ISLAND SOCIETIES? HOW IS STRESS TO BE MEASURED?

The answer to these questions appears to be that in some, but not all cases, stress was caused, and further that such stress could be particularly acute for small island societies. The increasing elaboration and size of monuments built by the Mayans in Mesoamerica is said by some scholars to have been stressful, and possibly to have led to that society's collapse. The case for and against this proposition is covered in greater detail in Chapter 3. On Easter Island the size and proliferation of the monuments built by its society certainly caused acute stress and contributed to its downfall (Chapter 3 covers this situation in more detail).

The stress of the direct effort in constructing monuments may not be an isolated phenomenon, in the sense that too much labour is demanded of a population otherwise involved in a subsistence existence. Labour demands sustenance and an excessive demand, that is one over and above what might be categorised as "free time", calls for further productive effort to assure food supplies. This, in turn, may lead to further demands on the environment leading to ecological degradation and a resultant downward spiral. It should be remarked, perhaps, that such an ecological downward spiral is not necessarily the result of the demand for labour for monument building, but can have its own dynamic arising from population growth, or other factors. For instance, as we shall see, one of the contributory factors in the decline of society on Easter Island was the import, by the colonisers, of rats which ate the nuts of the indigenous palm tree, thus inhibiting the palm's regrowth, and causing increasing treelessness.

It is essential when considering whether stress arose, and if so its degree of acuteness, to have some means of measuring it. The first, and less satisfactory, method of measuring stress is by observation of its apparent consequences. Such was the case on Easter Island: the society collapsed; why?; because the Easter Islanders exhausted themselves and their island by building too many monuments. The argument seems plausible but unproved. The second method of measuring stress is much more direct, through the use of the technique of energetics analysis. This technique is covered in detail in Chapter 3, but it is appropriate to give a brief resume here.

An energetics analysis seeks to reconstruct a monument in its original form, hypothetically, for each successive phase if more than one. The quantities of each constituent material are calculated and multiplied by the person-days involved in the procurement, transport, preparation and erection of each appropriate unit of each material; there is thus produced the total person-days of labour involved in each phase of the monument's construction. By relating these figures to the time over which the monument was built and the amount of labour available, the percentage of each available worker's time spent on the monument's construction each year may be computed. Such a calculation will be directly relevant to the question of possible social stress.

1.6 A BRIEF REVIEW OF SOME ISLAND SOCIETIES WHICH BUILT MONUMENTS

The purpose of this review is to give some examples of island societies which built monuments in order to illustrate the questions asked in the sections above, particularly those concerning boundedness, uniqueness of monuments, society structure and stress. It is hoped that by so complementing the preceding sections, these questions may be more particularly asked in relation to prehistoric Malta.

Easter Island lies 2250km from the nearest Polynesian islands, the Pitcairns, to the west and 3750km from the Chilean mainland to the east, and is only 160sq km in area. Most scholars consider that it was colonised by Polynesians from the west in c.300-500 AD. (eg. Bahn & Flenley 1992, Esen-Baur 1993, Van Tilburg 1994, Irwin 1992). Whether there was a second wave of colonisation is disputed: Esen Baur (*op. cit.*151) postulates one in the fourteenth century, also from eastern Polynesia, and that the fusion of these people with the existing population produced the cultural flowering seen c.1350-1650 AD. Irwin (1992 : 181), based largely on the unlikelihood of a further strike of such a small island over such a distance, considers that there was only one colonisation. Heyerdahl (1958, 1961, 1989) was led by the likeness of Easter Island stonework to that of the South American Incas to think that there must have been an influence from that continent, but this view is not held by other scholars.

From an original boatload of people (and their domesticates: chickens, rats, sweet potatoes etc.) the population increased to several thousand by c.1600 AD. Bahn (1993 : 54) suggests a figure of 6-8000, Renfrew (1972 : 161) suggests a figure of 3-4000 as more appropriate to the island's carrying capacity. By the time of the first European contact in the eighteenth century, the figure had declined to about 2000 (Bahn *op. cit.* 54).

From an early stage "The establishment of the Rapa Nui on their new island home required an adaptive transformation, technology and resource utilisation. A series of cultural selections took place in which aspects of their definition as a people were abandoned, while others were preserved - - - or emphasised in new ways. Choices were made by individuals on every level of the society which were prompted by the actual environment but also by their perception of the environment." (Van Tilburg 1994 : 51).

The outcome was what Sahlins (1955) called the "Esoteric Efflorescence in Easter Island". The earliest manifestation c.600-800 AD was the construction of Ahu, dressed stone platforms with associated burial vaults. As time went on, these became larger – one was 45m in length and 10m from front to rear. There are some 250 remaining Ahu on the island. About 1000 AD, the Ahu started to be embellished with giant stone statues, the stone for which was all quarried from one volcanic crater. Later still, many of the statues were furnished with "top hats" fashioned from red stone from another quarry. Both the Ahu and the statues are unique to Easter Island; but "it is not hard to derive [features of the statues] from other widespread Polynesian forms in stone and wood". (Bellwood 1987:26). The Ahu and their statues are found throughout the island, mainly along the coasts. The labour involved in their construction was enormous (see Chapter 3). It is thought that the driving force was a combination of ancestor worship and territorial marking by rival Polynesian style chiefdoms (eg. Metraux 1957, Renfrew 1973 a, Bahn & Flenley 1992).

Ahu and statue building ceased about 1600 AD. Many half-finished statues are found on the slopes of the volcano where their stone was quarried, and there are examples of statues abandoned part way to their destined Ahu. Overlapping for 150 years with the later period of Ahu-statue construction, there appears a new religious manifestation: the Birdman cult. There are relief carvings of creatures with human torsos and limbs, surmounted by birds' heads, featuring the curved beaks and gular pouches typical of frigate birds. There appears to have been some centralisation of, at the least, religious influence because these Birdmen are particularly associated with the south west corner of the island and possibly an annual ritual associated with an island off this part of the coast.

As reported by Renfrew (1973 a) and Routledge (1919), amongst others, Easter Island was peopled by ten tribes of Polynesian origin. Each of these tribes traced their descent back to a common ancestor, usually one of the first settlers or their sons or grandsons. One of these tribes traced their ancestry back to the senior original settler and thus provided the sacred paramount chief for the whole island. This principle of lineage seniority was similar to other Polynesian chiefdom societies. Inter-tribal rivalry was intense and may have been exacerbated by population growth and scarcity of land. It seems very possible that, by channelling the disputes this rivalry gave rise to into monument building, even more destructive warfare may have been avoided.

The first European contact was by the Dutchman Roggerveen in 1722, who found the statues still standing on their Ahu. Between this time and the visit of Cook in 1774, many of the statues had been toppled, it is assumed as a rejection of the Ahu culture by the ecologically stressed island society. This possible stress is further considered in Chapter 3.

The Balearic islands. Waldren (1982) and others have divided the later prehistory of the Balearics as follows:

Pre-Talayotic (Copper/EBA)	3400-1700 BC
Talayotic I (MBA/LBA)	1700-1150 BC
Talayotic II (LBA/EIA)	1150- 800 BC
Post-Talayotic (IA)	800- 300 BC

In the Talayotic period, Balearic societies developed a suite of unique stone structures, having no relation to the mainland nor to neighbouring islands, which took three forms:

- Burial structures known as navetas because of their resemblance to upturned boats. The more elaborate navetas had two storeys. It is thought that the upper one was for the storage of bodies while decomposing, and the lower one for the keeping of the resulting, disarticulated, bones.

- Talayots, which are stone built towers, often called "watch towers", though their purpose is uncertain. Usually an integral part of settlements, they might be round, oval or square and 10m across.

- Taulas, which consist of a flat monolith placed on top of an upright one, and usually surrounded by a horseshoe shaped stone enclosure. The supporting monolith might be as much as 5m high and the surmounting slab 5m long. Taulas, like talayots, are associated with settlements and are thought (eg. Waldren 1982) to have served as sanctuaries.

Labour expenditure on all these edifices was considerable, and it is clear that some form of religious activity was closely integrated with secular society. Several sites produced considerable quantities of animal remains, which might be the result of sacrifice or feasting or both. Navetas have only been certainly found on Menorca, talayots on both Menorca and Mallorca, as are taulas. It is not clear whether the absence of navetas on Mallorca is a product of differential preservation or original distribution. There are at least 36 (Waldren 1982) on Menorca, so it might be supposed that the probable total absence of navetas on the larger island of Mallorca, does indeed reflect original distribution. The two islands are separated by about 40kms and it is possible that, while sharing styles of monument for the living, they did not for the dead.

The building of all three types of monument ceased about 800 BC when Punic and then Roman activity influenced the area. As far as the author is aware, no quantified assessment of stress has been made.

On Sardinia, there was another unique development, with echoes, perhaps, in Corsica, but not elsewhere, which appears to have been entirely secular. This was the construction of "nuraghi" in the Bronze Age – Iron Age period, c.1800-500 BC. Nuraghi are thought to have been fortified residences at the centre of small settlements. Earlier ones are simple, round stone towers with space inside for people and perhaps animals, and are about 7m in diameter. Later nuraghi became much more elaborate with multiple, sometimes interlocking buildings. It is thought that nuraghi were the residences of petty-chiefs that would also become the refuge of the local society if under attack (Webster 1991, 1996; Trump 1991, 1992). They are numerous, over 7000 having being identified, and apart from the somewhat similar Torri on Corsica to the north, to which they are perhaps related, they are a special adaptation of the Sardinians to their society and environment. Webster (1991) has made an energetics analysis of Sardinian nuraghi and come to the conclusion that building them did not cause stress to their builders, contrary to proposals previously advanced by others. This analysis is covered in more detail in Chapter 3.

1.7 CONCLUSION

Both the general discussion at the beginning of this chapter and the brief review of some islands with unique monuments have been designed as a lead into considering the case of prehistoric Malta. By bearing in mind the questions asked and the pointers given by example, we intend that the question asked in the title, "Insular Monument Building : a cause of social stress? The case of prehistoric Malta", be given as comprehensive an answer as possible.

CHAPTER 2

A DESCRIPTION OF THE MALTESE ISLANDS AND THEIR PREHISTORIC CULTURES

2.1 THE ISLANDS

The Maltese islands stand in isolation in the central Mediterranean. The nearest land is Sicily 80kms to the north. Westwards, North Africa is nearly 300kms distant. See Fig. 2.1.

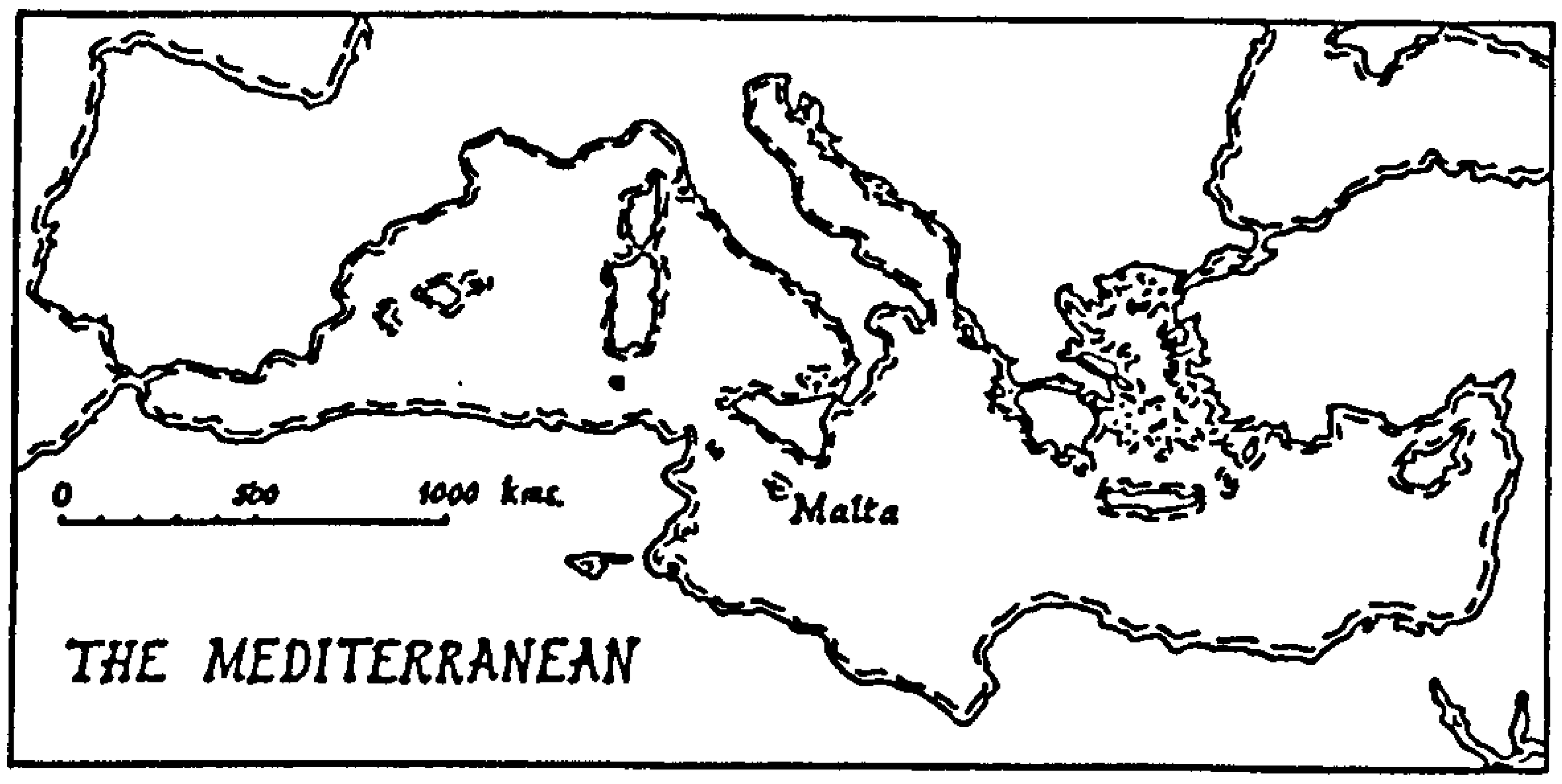


Fig. 2.1 Location of the Maltese Islands. See footnote.

There are three main islands. Malta itself has an area of 243sq km. To the north-west lies Gozo, separated from Malta by a 5km wide channel and with an area of 69sq km. Between the two lies Comino, 2sq kms. In addition, there are a number of insignificant islets. See Fig. 2.2.

Footnote: Source references for figures which are not the author's are given in Appendix 1.

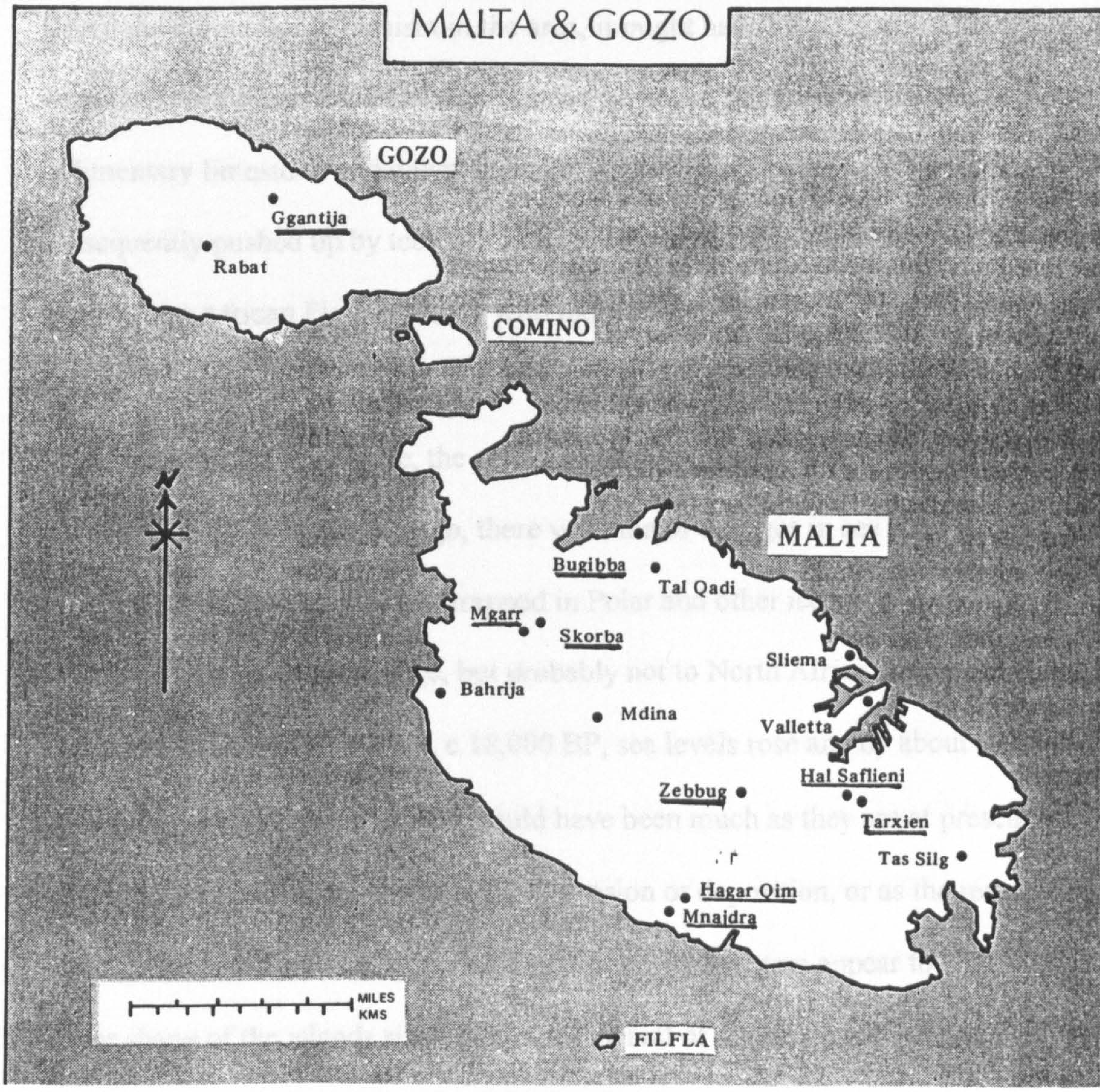


Fig. 2.2 The Maltese Islands. Temple sites underlined.

In considering the colonisation and prehistory of the islands it is necessary to set out the environment that faced the settlers and this is done in the sections that follow.

2.2 GEOLOGY AND TOPOGRAPHY

The following description of the geology and topography of the islands has drawn on Evans (1959), Trump (1990 b), Bonanno (1990 b) and especially Zammit-Maempel (1977) as well as the author's own observations, helped by the excellent geological maps of the islands.

Given the amount of vulcanism in the area, it might have been expected that the islands were the result of such activity. This is not, however, the case; the islands consist of sedimentary limestone laid down undersea in the Miocene era (c.25-5 mya) and subsequently pushed up by tectonic action. This happened in the Pliocene (c.5-2 mya) as a result of the African Plate colliding with the Eurasian Plate.

In the succeeding Pleistocene, the period of ice ages with intermittent, warm interglacials, starting about 2 million years ago, there were major changes in sea level resulting from the variation in the amount of water trapped in Polar and other ice caps. At times, Malta was joined to Sicily by a land bridge, but probably not to North Africa. Following the maximum of the last glaciation, c.18,000 BP, sea levels rose and by about 10,000 BP. the boundaries of the Maltese islands would have been much as they are at present, except for relatively minor coastline changes due to erosion or deposition, or as the result of tectonic faulting, discussed later. Neither tectonic nor eustatic factors appear to have altered the size or shape of the islands since before the arrival of the first colonisers in about 5000 BC.

The basic geological stratigraphy of the islands is as follows, working upwards from the lowest stratum:

- Lower Coralline limestone: a hard semi-crystalline limestone rich in marine fossils and hard in nature.

- Globigerina limestone: a golden soft stone named after the shells of *Globigerina*, which, with other Foraminifera, form the bulk of this material.

- Blue Clay, laid down by down-wash from the hills surrounding the Mediterranean as it then was.

- Sporadic areas of green sand.

- Upper Coralline limestone: similar in composition to Lower Coralline limestone.

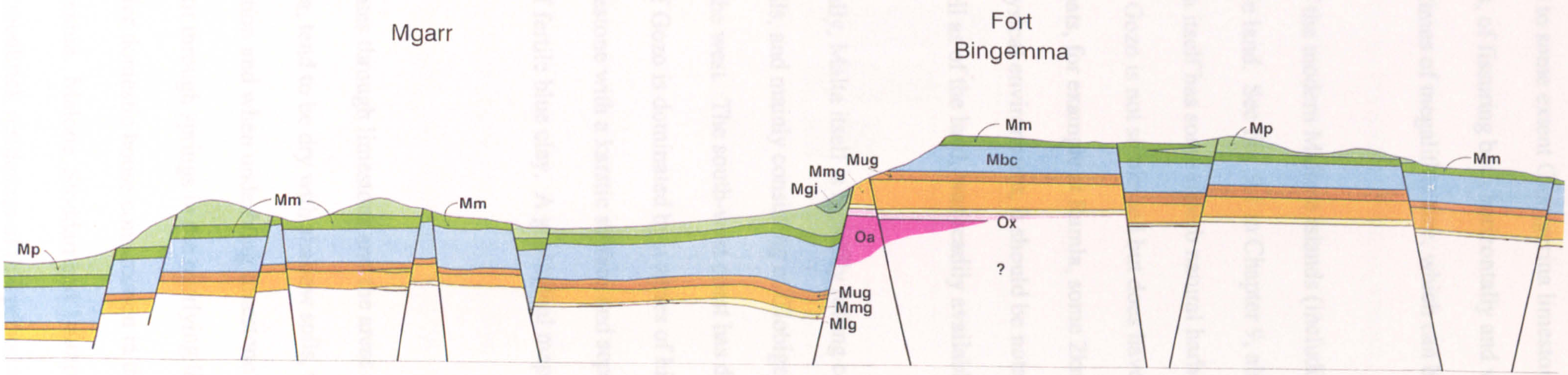
All these strata appear in thicknesses varying from a few metres to hundreds in the case of the three limestones.

The simple stratigraphy described above, has been disturbed by major tectonic movements, tilting, bending and faulting the original structure, which has occurred during and since the Pleistocene. There is some evidence that these tectonic disturbances, including faulting, may have continued since Neolithic times (Zammit-Maempel 1977 : 18). A major fault line is visible on Malta itself (the Victoria lines, a site of British fortifications), where the down-throw is in parts as much as 180m. Throughout the islands, there are many other fault lines, which are important because of the way they exposed useable outcrops of stone.

As an illustration of these tectonic effects Fig. 2.3 shows the geology around the temples of Hagar Qim and Mnajdra on Malta (further discussed in Chapter 5.) A north-south section through west Malta is shown in Fig. 2.4 and clearly demonstrates the degree of movement that may occur.

Fig. 2.3 The geology of the Hagar Qim/Mnajdra area

For colour code see Fig. 2.4. Scale 1 : 25,000



N - S PROFILE SECTION OF WEST MALTA

Fig. 2.4 A north-south geological section through west Malta.

Colour code :	Greens	=	Upper Coralline limestone	Blues	=	Blue Clay,
	Yellows/Browns	=	Globigerina limestone,	Purples	=	Lower Coralline limestone

Horizontal Scale = 1 : 25,000. Vertical Scale = 2.5 x horizontal scale, ie. 1cm = 100m.

Coralline and to some extent Globigerina limestone have the convenient property, in exposed areas, of fissuring both horizontally and vertically and thus providing building blocks, sometimes of megalithic size, which can be easily extracted.

Some 60% of the modern Maltese islands (including areas now built over) are classified as possible arable land. See Fig. 9.1 in Chapter 9, also Renfrew (1973 a), Said-Zammit (1997). Malta itself has some superb natural harbours, notably those at Valetta and Marsaxlokk. Gozo is not so blessed but does have bays perfectly suitable for beaching prehistoric boats, for example at Ramla, some 2kms from the Ggantija temples. Finally, in relation to physical environment, it should be noted that being small islands, the produce of the sea, as well as of the land, was readily available.

Topographically, Malta itself is typically rolling country, punctuated by fault lines and occasional hills, and mainly consisting of Globigerina limestone in the east and Coralline limestone in the west. The south-west coast has dramatic cliffs falling into the sea. The topography of Gozo is dominated by a series of hills, capped by plateau-like Upper Coralline limestone with a karstic surface and separated by Globigerina limestone areas and valleys of fertile blue clay. A geological map of part of Gozo may be found in Fig. 5.5 Chapter 5.

Water percolates through limestone and the areas of exposed limestone, whether Coralline or Globigerina, tend to be dry with shallow soils, very subject to erosion. Blue clay arrests water percolation and when underlying limestone facilitates the formation of aquifers, which may exit through springs in the overlying limestone. Blue clay also provided the raw material for domestic house construction in the temple building period of the fourth and third millennia. Malone, Stoddart and Trump (1988) report on the excavation of wattle and daub and mudbrick residences of this period at Ghajnsielem Road, Gozo.

2.3 CLIMATE

The data for this section come, in the main, from Chetcuti, Buhagia, Schembri and Ventura (1992), supplemented by the author's own experience, particularly of the extremes of temperature and rainfall of which the Maltese islands are capable. The islands have a typical Mediterranean climate with hot, dry summers and cool, wet winters. See Fig. 2.5.

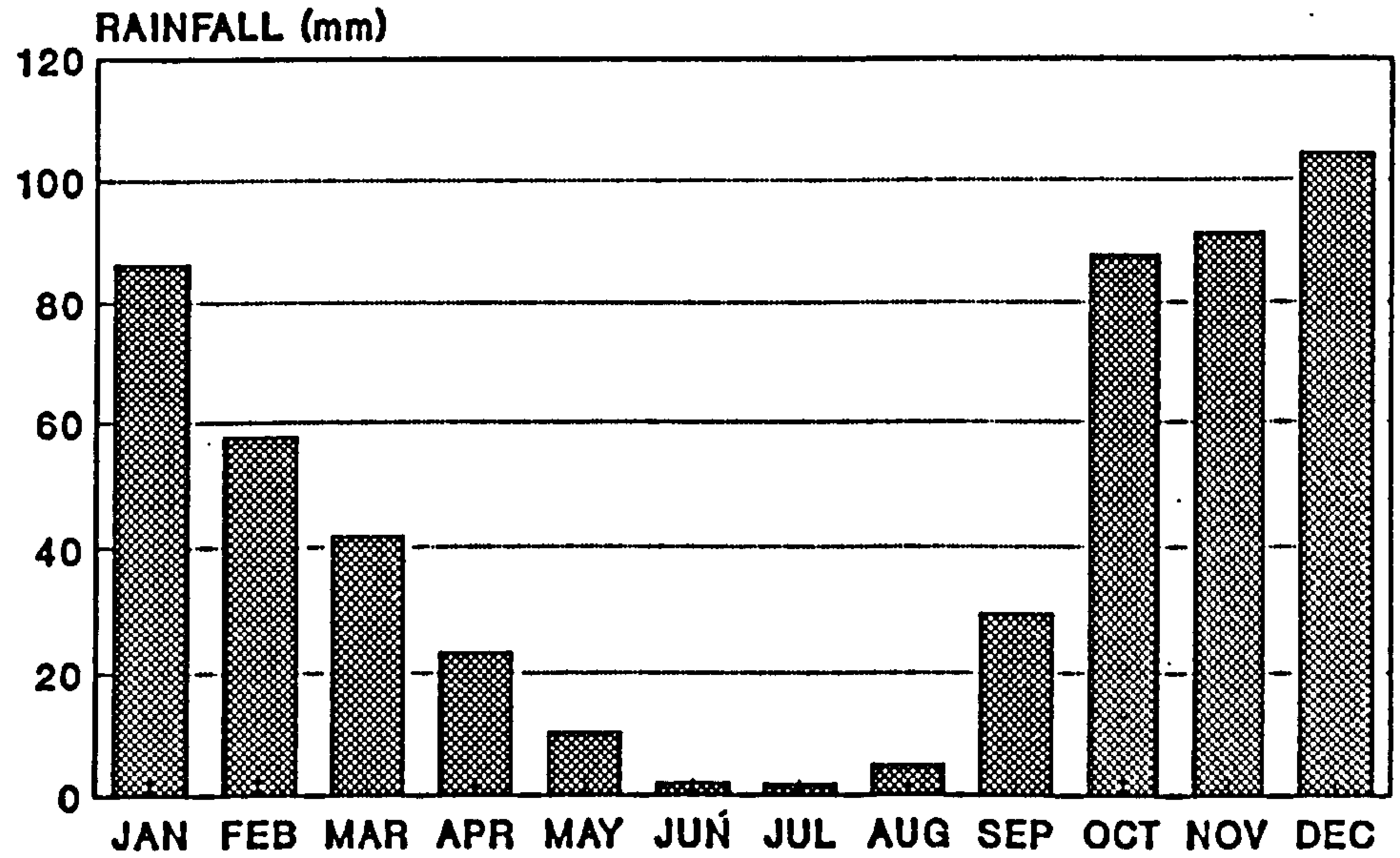


Fig. 2.5 Mean monthly rainfall 1854-1986

These averages hide high inter-annual variations. For example, over the period covered in Fig. 2.5, the lowest October rainfall was nil and the highest 586mm. Similarly, the total annual rainfall varies significantly: see Fig. 2.6. Variations occur over the islands' landmasses but are probably less significant than the two variations noted above,

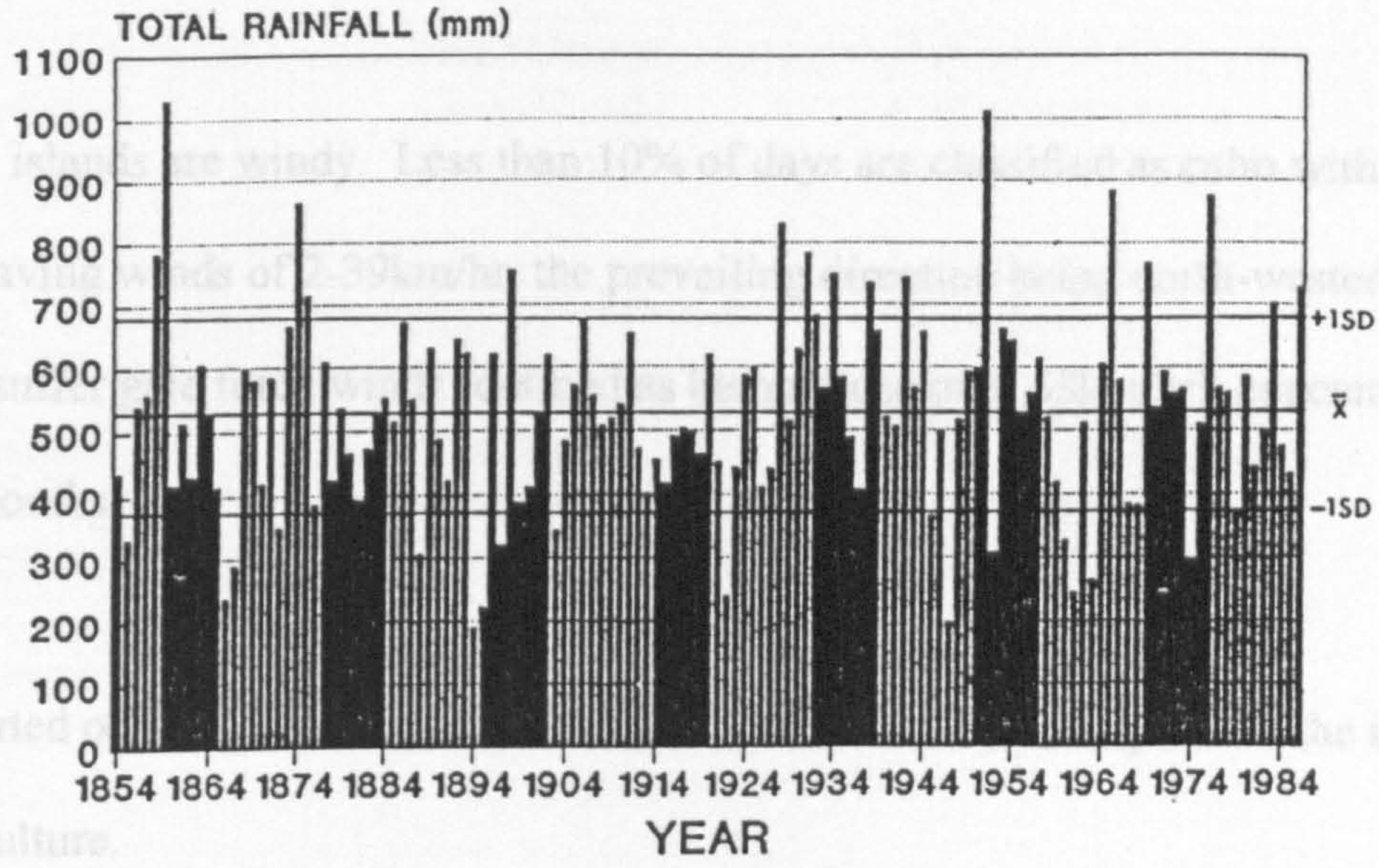


Fig. 2.6 Total yearly rainfall 1854-1986

(Mean/rainfall X and one standard deviation above and below the mean.)

Temperatures are typically Mediterranean, hot in summer and cool in winter. See Fig. 2.7.

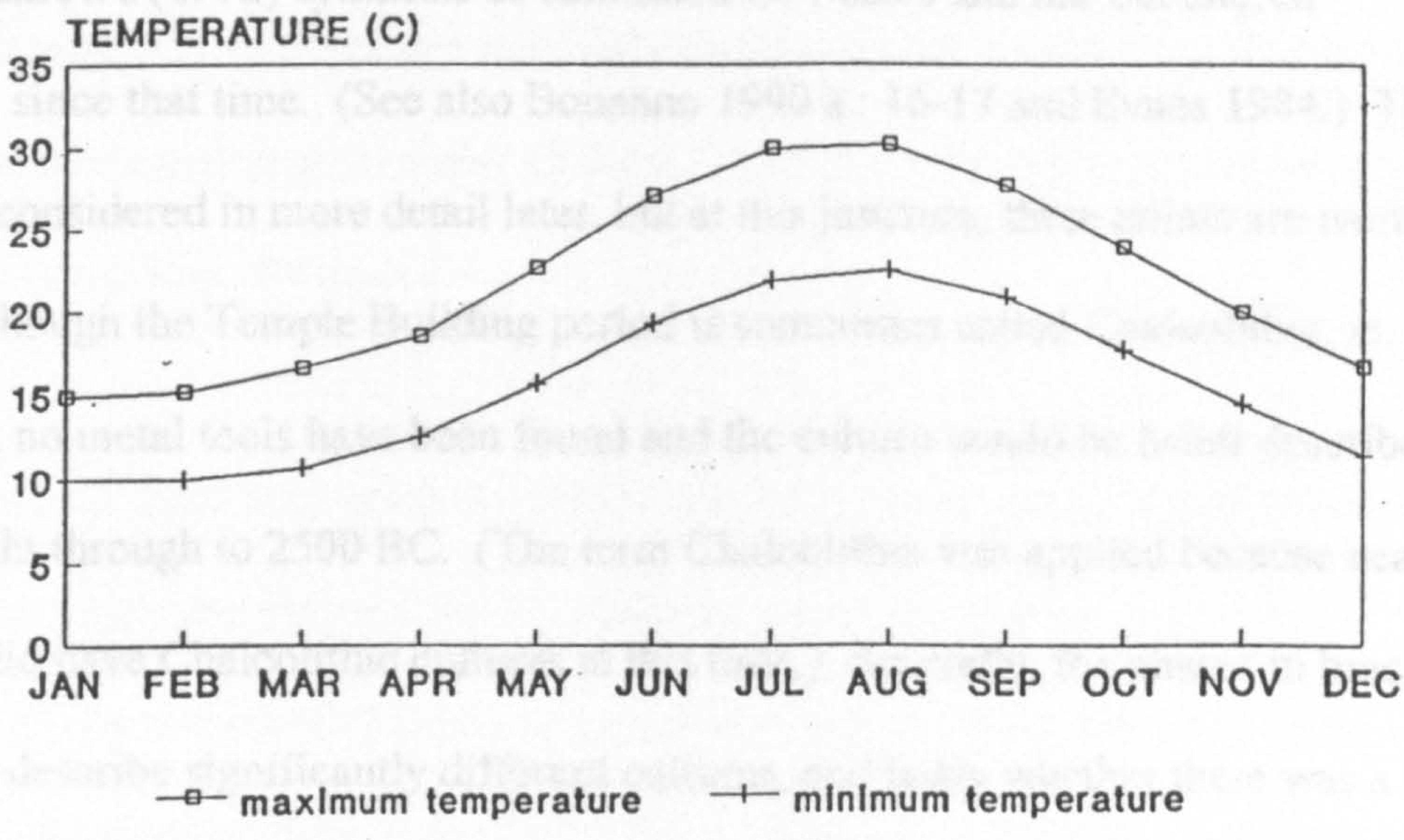


Fig. 2.7 Average maximum and minimum temperatures.

Mean daily maximum and minimum air temperatures, which are the averages of the maximum and minimum air temperatures recorded daily for each month 1951-1986.

Within these averages, there are much greater individual extremes: 43°C was recorded in July 1988 and 1°C in January 1981. Slight ground frosts can occur in January and

February.

The Maltese islands are windy. Less than 10% of days are classified as calm with most other days having winds of 2-39km/hr, the prevailing direction being north-westerly. All months can suffer gale force winds (defined as being those over 63km/hr), concentrated in the winter months.

Having reported on the Maltese environment, we turn now to a description of the islands' prehistoric culture.

2.4 OUTLINE OF PREHISTORIC MALTESE CULTURES

The generally recognised sequence of prehistoric Maltese cultures is set out below. It is based on Renfrew's (1972) synthesis of calibrated C14 dates and has not altered significantly since that time. (See also Bonanno 1990 a : 16-17 and Evans 1984.) The cultures are considered in more detail later, but at this juncture, three points are worth making. Although the Temple Building period is sometimes called Chalcolithic, ie. Copper Age, no metal tools have been found and the culture would be better described as Neolithic right through to 2500 BC. (The term Chalcolithic was applied because nearby Italy/Sicily did have Chalcolithic cultures at this time.) Secondly, the phases in brackets do not really describe significantly different cultures, and lastly whether there was a hiatus between Tarxien and Tarxien Cemetery is a matter of dispute – discussed later – hence the question mark.

Period		Phase	Dates
	)	Ghar Dalam	5000-4500 BC
Neolithic	)	Grey Skorba	4500-4400 BC
	)	Red Skorba	4400-4100 BC
		Zebbug	4100-3600 BC
		(Mgarr	3800-3600 BC)
Temple	)	Ggantija	3600-3000 BC
Building	)	(Saflieni	3300-3000 BC)
Period	)	Tarxien	3000-2500 BC
Bronze	)	Tarxien Cemetery	?2500-1500 BC
Age	)	Borg-in-Nadur	1500-700 BC

2.5 BOUNDEDNESS : THE QUESTION OF CONTACT

Prior to the radiocarbon revolution explanations of the origins of the Maltese islands' cultures were full of influences from overseas, many from the eastern Mediterranean, but some also from Italy. Pottery styles were traced to Crete, temple architecture to Mycenean tholos tombs, "fat lady" statues to middle eastern mother goddesses and so on. The advent of radiocarbon dating proved that all these – except perhaps the last – significantly pre-dated the proposed prototypes.

Nevertheless, there were contacts. There are the obvious ones of initial colonisation and the Bronze Age immigration, with perhaps an intervening one at the start of the Zebbug period. Malta is short of at least one essential requirement for neolithic existence: flint or obsidian for use as cutting tools. Some low grade chert is available, but is not very satisfactory for this purpose. Thus throughout the Neolithic/temple building periods, people were dependent on offshore resources. The ability to provenance obsidian (Cann and Renfrew 1964) has shown that the Maltese drew supplies from both the Lipari islands north of Sicily and from Pantelleria island to the west. Whether either or both of these were obtained through Sicily as an intermediary, is unclear, as is the question of whether trade was involved. In addition to obsidian, brown flint was imported from Sicily. Trump (1966 : 50) gives some interesting figures for the source of obsidian artefacts he found at Skorba: (adapted by author).

	Lipari	Pantellaria
Ghar Dalam	99	21
Grey Skorba	29	11
Red Skorba	70	1
Zebbug	25	3
Ggantija	33	4
Tarxien	15	1

Obsidian and perhaps flint were the only essential materials required for Neolithic subsistence which were not available to the occupants of the Maltese islands.

In addition, there were other needs which could not be satisfied in Malta, perhaps the most important of which was red ochre, used both in burials and on the walls of some temples and in the Hal Saflieni hypogeum. This was available in Sicily. Stoddart and his colleagues (1993 : 7) report that: "Caches of ochre, collected for transport perhaps to Malta, have been found at Serra del Palco near Milena in Sicily (Maniscalo 1989)." It would seem that this would certainly have been a matter of trade, requiring something in return. From the Late Bronze Age "Maltese textiles had a high reputation, which may have begun unrecorded much earlier". (Trump 1966 : 50).

Apart from these essentials and needs, there is evidence of other imports to the Maltese islands: some may have been purposeful and some fortuitous. Among the latter are some Aegean sherds, but they probably arrived after the temple building period. Amongst the former are lava for querns, from Etna, alabaster for figurines from either Agrigento or Calabria and green stone axes from Calabria. (Trump 1966, Stoddart and colleagues 1993). Where pottery of similar style is found in both Malta and Sicily, it is often very difficult to determine whether this was indigenous or imported.

This then is the archaeological evidence for contact. Interpretation of it varies enormously. On the minimalist side, Trump (1966 : 51) states: "No large numbers of visitors, pilgrims, or traders, could have passed through Malta leaving so little trace. Until the mid-sea routes were opened up by the Phoenicians, there was in any case nowhere to pass through to; Malta's sole route was to or from south east Sicily. The non-local raw materials were almost certainly imported thence in Maltese craft". Malone and colleagues (1993 : 83) say in relation to the Tarxien period: "fewer materials were imported into the islands during this time of crisis than in the more fruitful era" (ie.in the Ggantija period). Stoddart and colleagues echo this assessment (1993 : 7) "the import and deposition of green stones and obsidian and other foreign materials become increasingly rare - - - in the Tarxien period". And again the same authors (*op. cit.* 17) "exotic products, which were common in the pre-temple building Zebbug period, were increasingly scarce in the precise period during which most active temple construction and elaboration occurred."

On the other side are ranged, for example, Brea (1960 : 133-4) who, in reviewing Evans (1959) says: "One thing seems to me quite certain, namely that such a splendid culture, [the Maltese temple period] artistically so much alive, cannot be simply the result of local evolution - - - the flowering of Maltese culture can only be explained - - - as the result of an intensive maritime and commercial activity which presupposes exchanges - - - the natural consequence of Malta's obligatory port of call on all the routes which link the east and west Mediterranean. Indeed -- - the cultural superiority of Malta over Sicily is due precisely to the fact that Sicily, agriculturally so much richer was able to lead a closed life - - - while Malta - - - had to seek new sources - - - across the seas".

Evans (1959 : 160-1) states: "we can be fairly sure that the Maltese islands were connected by a web of trade relations that were more than sporadic with most of the neighbouring lands of the western Mediterranean".

Cassar (1997 : 139) states: "Bearing in mind that the [Maltese] archipelago lies in the narrow channel which joins the eastern and western basins of the Mediterranean, it should not be unreasonable to assume that architectural practices were both imported and exported by the primitive inhabitants, particularly with the arrival of new cultures".

The author is more persuaded by Trump's deduction from the evidence, as set out above, than by those scholars arguing for a greater degree of contact.

2.6 THE PRE-TEMPLE BUILDING PERIOD

Although, as described in the previous chapter, a land bridge to Malta from Sicily would have been available in the last ice age, there is no evidence of Palaeolithic occupation of what is now Malta, (despite excitement about the discovery in 1917 of what appeared to be Neanderthal teeth at Ghar Dalam cave, subsequently found to be unproven (Evans 1959 : 36).) First settlement came in around 5000 BC by neolithic farmers from Sicily. The evidence that they came from Sicily is firstly that it is the nearest land, 80kms to the north, and more tellingly that the tools and the pottery they used can be identified with those in contemporary Sicily, particularly Stentinello ware and perhaps also Monte Kronio. This pottery has impressed decoration. (Evans 1959, 1984, Trump 1990 b, Bonanno 1990 b). Trump (1966) excavated the site of Skorba, whose earliest occupation was in the Ghar Dalam phase c.4800 BC, which yielded information on the farming practice at that time: remains of sheep, goats and cattle were found, together with barley, emmer and club wheat, and lentils. The name of this phase, Ghar Dalam, is after the type site of the cave of that name in Malta where remains of this first culture were found, overlying successive animal remains stretching back into the Pleistocene.

The succeeding Grey Skorba and Red Skorba phases were thus named by Trump (1966) following the pottery styles found by him in strata at Skorba. These styles were simpler than Ghar Dalam pottery, often plain of grey then red ware, and when decorated, incised rather than impressed. Trump (Evans 1984) considers that the first three phases were successive, indigenous developments, and although perhaps influenced by continuing contacts with Italy or Sicily, did not represent a fresh colonisation.

The Zebbug phase, starting in about 4100 BC, does represent a striking change compared with the preceding Red Skorba phase. The pottery has affinities with the San Cono/Piano Notaro and Conzo styles of southern Sicily. New shapes are evident – a pear shaped jar being typical – and new decorations of painted or incised lines, the latter often filled with white or red paste. Continuing contact with Sicily is thus clear. The Zebbug phase sees the first evidence of rock cut tombs for collective burials. Whether these are connected with the appearance, at about the same time, of single or double rock cut tombs in Sicily, is not clear. Trump (1981 : 64-5) thinks not. Evans (1984 : 493) is more cautious in making a judgement. It is not clear whether the Zebbug phase was started by a new immigration of people from Sicily, or was merely a response to contact. Trump (1981 : 64) is unequivocal: "The immigrants who initiated the second cycle of cultural development - - - the Zebbug phase - - -". By 1990 (b, 20) he is more cautious and uses the word "perhaps": Bonanno (1990 a : 20) says: "a new wave of immigration from Sicily" is indicated: Evans (1984 : 493) urges "caution in assuming that the changes indicate any major change in the population". That the Maltese were capable of developing something entirely new and their own is abundantly evident from their subsequent unique temples and the temple furniture. But in the case of the Red Skorba/Zebbug break what was new to Malta was already in existence on Sicily. The author feels that this change came about as a result of a new wave of immigration and not merely as a consequence of continuing trading contact. This conclusion cannot be proved but seems the more plausible.

2.7 THE TEMPLE BUILDING PERIOD

2.7:1 The Temples

In about 3600 BC, the Maltese people started building their "Temples", stone structures unique to the Maltese islands. There had been signs of religious practice in the later Red Skorba phase at Skorba, where a building of two oval chambers, containing figurines, suggested possible use as shrines (Trump 1966, 1981). No evidence for above ground religious activity in the Zebbug phase has been found. However, it is plausibly argued that the multi-chambered rock cut tombs of the Zebbug period may have been the inspiration for above ground temples, similar in plan. See Figs. 2.8, 2.9 and 2.10.

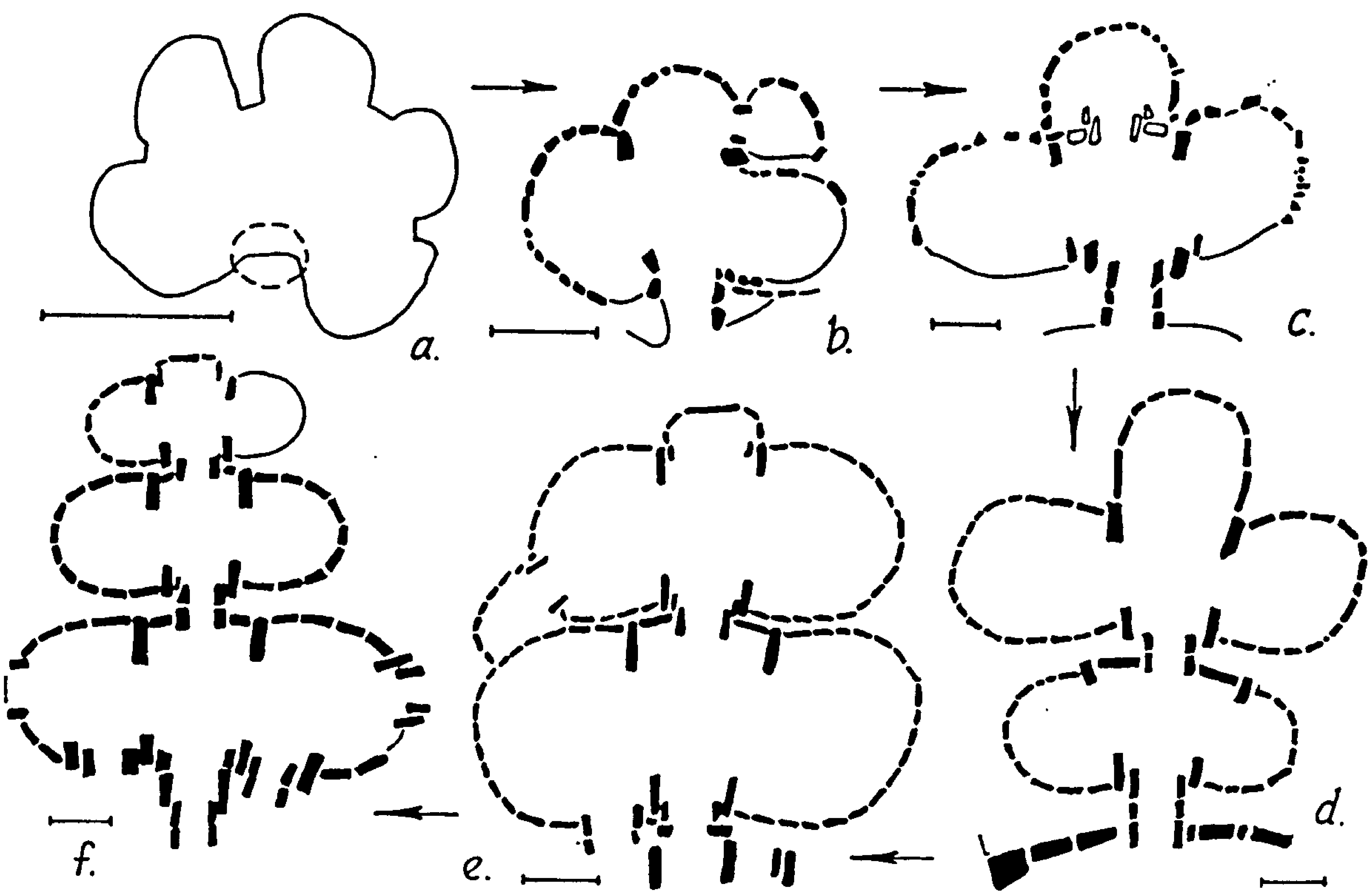


Fig. 2.8 The Evolution of the Maltese temples.

a. rock cut tomb at Xemxija; b. lobed temple, Mgarr East; c. trefoil temple, Skorba West; d. 5 apse temple, Ggantija South; e. 4 apse temple, Mnajdra Central; f. 6 apse temple, Tarxien Central. Each scale is 3m.

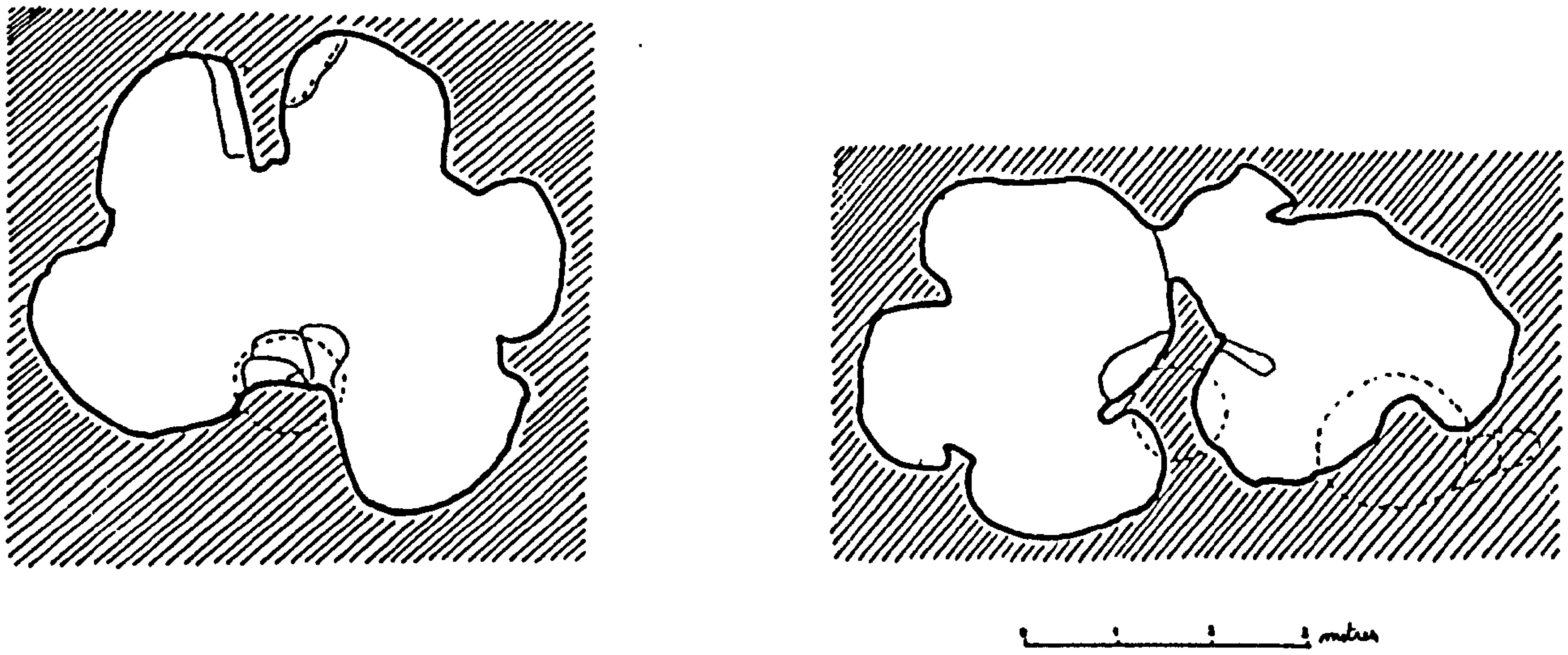


Fig. 2.9 Tombs 5 (left) and 1 and 2 (right) at Xemxija

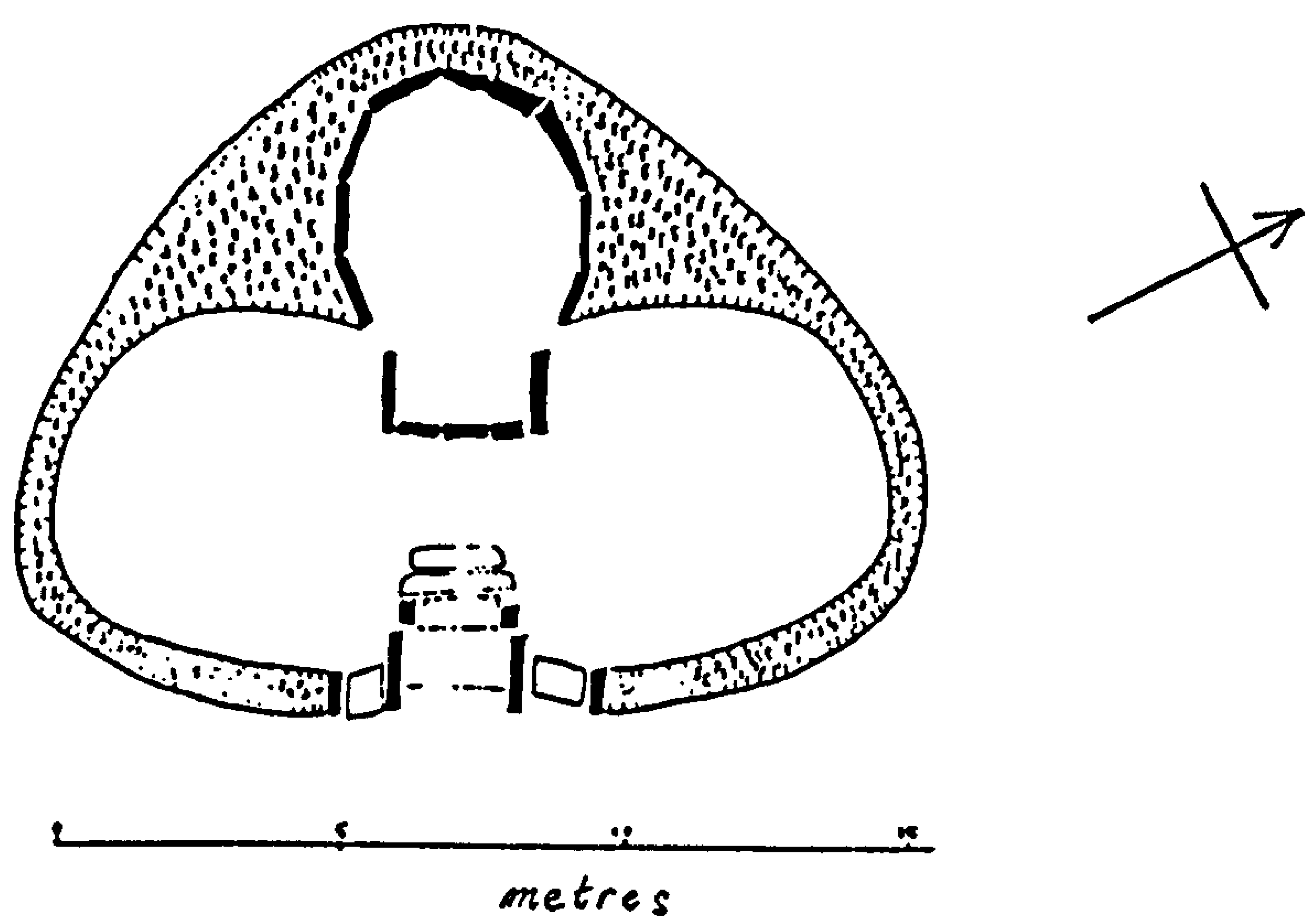


Fig. 2.10 Plan of trefoil temple at Mnajdra

Fig. 2.11 Aerial view of Ggantija temple, Gozo, from the north east.

All the temples, built throughout the period 3600-2500 BC, have features in common. A perimeter wall, often of megalithic construction, surrounds an inner structure of "apses" with an entrance portal and interconnecting passages. The gaps between the outer perimeter wall and the apse walls, are filled with stone and earth rubble. The entrance side of the perimeter wall was typically concave with a terrace platform in front of it. The temples are scattered over the Maltese islands and all the major ones have the feature of being in adjoining pairs, or in some cases, as at Tarxien, more than two conjoined. They were built of the stone local to their sites, although when this was Coralline limestone, Globigerina limestone, more easily dressable, might be brought in from a distance. Fig. 2.11 shows an aerial view of Ggantija temple, which is built of Coralline limestone and exhibits the features outlined above. A much more detailed description of this temple is given in Chapter 4.

There was a pattern to the development of temple plans over the temple building period. It is illustrated in Fig. 2.8. The earliest temple plan was a simple lobed one, such as that in Fig. 2.8b, built in the Ggantija phase. This was followed by trefoil (Fig. 2.8c), and five apse versions (Fig. 2.8 d). Succeeding these were four apse temples (Fig. 2.8e) and the only six apse one (Fig. 2.8f) in the Tarxien phase. The sequence was not in fact quite as simple as this: for example, a lobed temple at Mgarr East is dated to the Ggantija/Tarxien crossover (Saflieni); and the four apse temple at Ggantija is dated to the Ggantija phase; unlike the others, which are Tarxien. A plan illustrating the four and five apse temples at Ggantija is given below: Fig. 2.12.

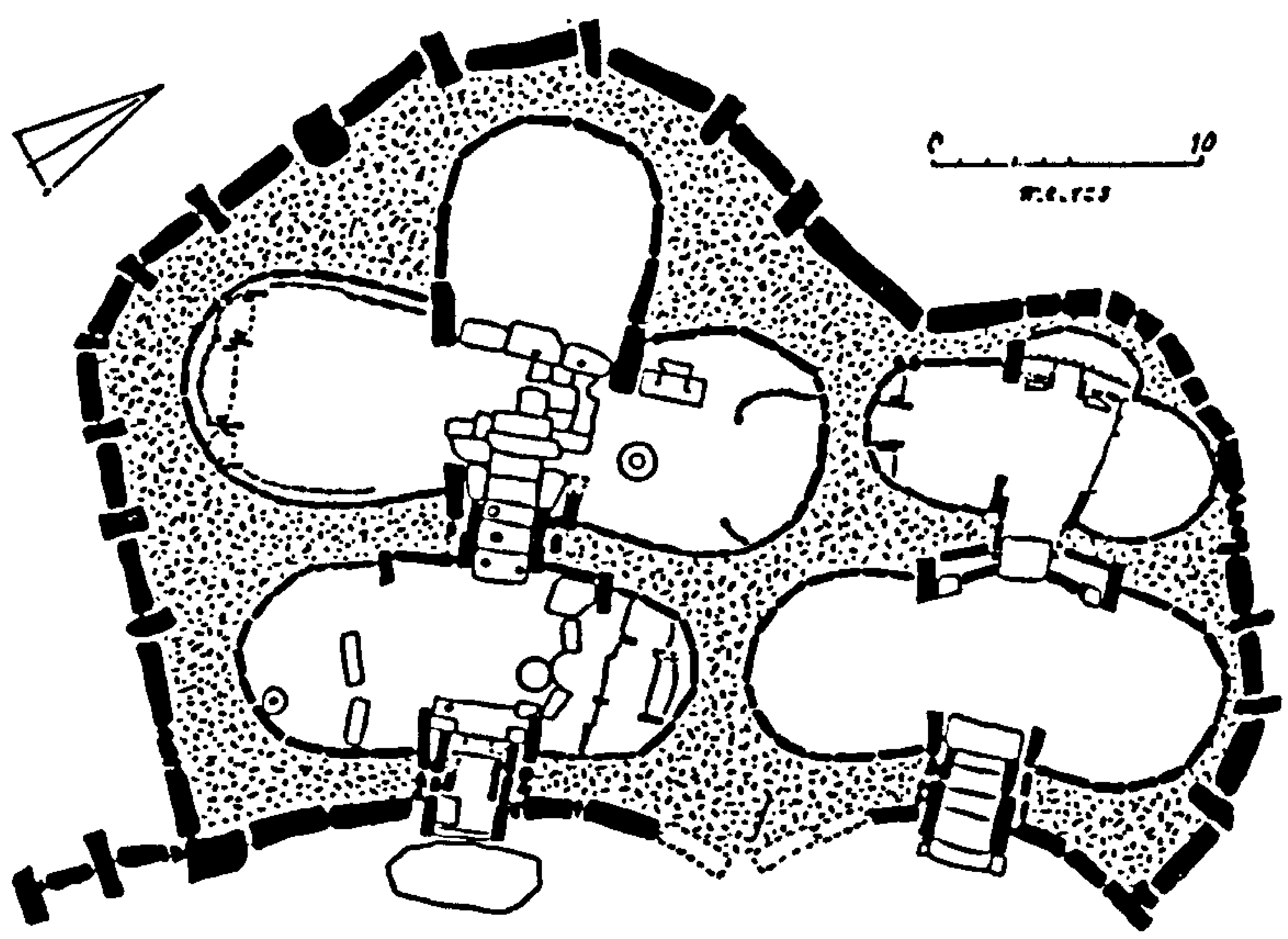


Fig. 2.12 Plan of Ggantija Temples

The distinction between the Ggantija and Tarxien phases of the Temple Building period is not well defined, or at least it is not abrupt. As noted above, the plans of the temples are not definitive. Tarxien period pottery, although better fired and finished, and more diverse in shape with incised decoration of evolving pattern in this period, is nevertheless no more than a development.

The temples themselves, in addition to those of their plans, show other developments over time. The majority of the earlier ones were built in the main of Coralline limestone, relatively easily extracted in fissured blocks. The apse walls constructed of these blocks might be smoothed with daub infill, plastered and painted (as at Ggantija and Skorba) but only the portals and internal furniture were of dressed Globigerina limestone. Most later temples were built on or near to Globigerina limestone outcrops. This stone was dressed to smooth ashlar blocks and the architectural and building skill involved in their construction was very considerable. The outside of the temple at Hagar Qim, illustrated in Fig. 4.34, demonstrates this. Also at Hagar Qim is an indication of the builders' understanding of the use of horizontal arches, covered in the discussion in Chapter 4.

There are some superb carvings in Globigerina limestone, some three dimensional and some surface carvings of blocks. The majority of these come from Tarxien, which is probably the result of differential survival (only Tarxien and Skorba have been excavated using modern archaeological techniques). These stone carvings are complemented by fine pottery. The question of the use of the temples is covered in a later section of this chapter. What should be stated at this stage, is that they were temples. Collin's English Dictionary defines temples as "a building or place dedicated to the worship of a deity or deities - - - a building regarded as the focus of an activity, interest, or practice". The size and design of the buildings appear to rule out domestic use and there are no signs of burials. Inside the buildings furnishings which can most easily be identified as altars abound, indeed at Tarxien one such altar was found to hold animal bones and a long flint knife, indicating sacrifice. In the Tarxien period (as discussed later in this chapter) there appear the trappings of a contrived engineering of "mystery". So it seems safe to assume that these buildings were temples, as defined above.

In parallel with the building of the temples was the construction of the two known hypogea: that of Hal Saflieni near Tarxien and of the Xaghra Stone Circle near Ggantija. These are each a series of underground chambers used for the burial of the dead and for ritual purposes associated with the dead. The Xaghra Stone Circle utilised existing underground caves in the Coralline limestone of the Xaghra plateau. The Hal Saflieni hypogeum is a human construct, being a series of chambers on several levels carved out from the soft Globigerina limestone in which it is situated. The earliest of these is reminiscent of the pattern of the tombs at Xemxija mentioned earlier. The later ones are much more elaborate and echo the fine Globigerina limestone temples of the later Tarxien period at Hagar Qim and Tarxien itself. As discussed in Chapter 4, these chambers have often been cited as evidence for the form of temple roofing. There are illustrations of Hal Saflieni in Chapter 4. Hundreds, or in the case of Hal Saflieni, thousands of articulated and disarticulated human skeletons were found in the hypogea.

2.7:2 CULTURAL DEVELOPMENT DURING THE MALTESE TEMPLE BUILDING PERIOD

Any consideration of cultural development must have as the starting point the remains of the culture that are available for study, and its chronology. In what follows by way of factual description, use has been made of Evans (1959, 1971, 1996), Trump (1966, 1981, 1990 b), Malone, Bonanno, Gouder, Stoddart & Trump (1993), Stoddart, Bonanno, Gouder, Malone & Trump (1993), Malone and Stoddart (1996).

The temples have already been briefly described in their physical form, and it has been argued that they fulfilled some religious function. The temples were frequently in pairs, with the younger of the two on the right, facing their entrances, this second temple tending to be of a less accomplished construction. Tarxien and Hagar Qim were more complicated in having more than two temples. The temples were entered via a platform which could have accommodated considerable numbers of people. Entry was through a portal in a very imposing, concave façade. As has been noted, this gave onto a varying number of apses.

The apses and the through passages might be furnished with carved blocks, altars, human and animal figures and pottery bowls. Tarxien, being the best excavated of the larger temples, provides the most information. At the further side of the first right hand apse of Tarxien's western temple, there was an altar with a spirally decorated base, having an opening behind which were found animal bones including a goat horn, presumably the result of sacrifice with the long flint knife blade also found in the altar. Animal bones were also found in the stone "cupboards" in the more rearward apses. Libation holes in the floors were presumably for liquid offerings, a supposition perhaps confirmed by the presence of many varying sized pottery bowls, some either so large or so small that they could hardly have been useful as domestic utensils. In some temples, for instance at Tarxien Hagar Qim and Mnajdra, are so called oracle holes in the apse wall slabs. These give onto small rooms formed in the space between the apse wall and the perimeter wall, with access usually from the outside. The oracle openings were small and were presumably the communication link between someone inside the small room and those in the apse. It should be noted that these all occur in Tarxien period temples, ones whose apse walls were of Globigerina limestone.

In the uprights of the portals forming the junction between pairs of apses (other than the three lobed forms) may be found holes, made it is presumed to hold doors or curtains across the openings. (The less likely but possible use was to tether sacrificial animals.) As the temples were roofed (see Chapter 4) and if doors or curtains were placed across openings, the areas enclosed would have been completely dark, apart from any artificial light from torches. In this respect, they would have been the same as rooms in the hypogea. The more permanent temple furnishings, that of carved stone blocks, show a progression from sparse pitting to more dense pitting to spiral, sometimes elaborate spiral, designs and finally animal representations. These may be found on blocks across, or either side of, portals, or as a form of screen across apses, or on altars. The animal representations are of sheep, goats, pigs and cattle (a pig at Tarxien complete with her litter) being the animals sacrificed. At Ggantija there was a representation of a snake. Elsewhere, there were birds and fish, and at Hagar Qim what appears to be a potted plant decorating the four sides of an altar.

There are a very large number of human-form figures and figurines in both stone and terracotta from Tarxien and elsewhere. These were found throughout the temple interiors. There are all sizes, ranging from the huge seated one found at Tarxien, which must originally have been 2.5m in height, down to representations only centimetres high. They may be standing, squatting, or seated. Some are naked, some clothed in long pleated skirts reaching to the calves or feet. They are obese, with very exaggerated buttocks, thighs, legs and arms, and small hands and feet. A notable feature is that there is no clear indication of sex, despite the fact that they are popularly called "fat ladies", presumably because human females have more pronounced hips than males. Many, though not all, have separate heads. This is not a product of carving technique, but in order that the heads could be moved by strings placed through holes in the rear of the heads. Judging from the examples of secure provenance, this feature of "puppet" heads seems to be restricted to the Tarxien period. (Author's observation.) There are examples of larger, seated, pleated skirt figures with diminutive nude, obese figures on either side of the feet (eg. Evans : 1971 p.143 and Plate 48)

These "sexless" obese figures contrast with earlier and contemporary unequivocally female figures in terracotta, also found in various positions in the temples. An early one dating to the Red Skorba period was found by Trump at Skorba and has unmistakable exaggerated breasts and genitalia. A later one, the famous "Venus of Malta", with clearly defined breasts, is from Tarxien period Hagar Qim. These figures are much more naturalistic than the obese stone figures described above. There are no overtly male figures. There are, however, carvings of unmistakable phalli, sometimes multiple and framed in a niche (eg. Evans : 1971 p.145 and Plates 10 and 11) from Tarxien.

Constructed in chronological parallel with the temples were the two known hypogea, Hal Saflieni associated with Tarxien and the Xaghra Stone Circle near Ggantija. These are both burial complexes containing, certainly in the case of the Xaghra Stone Circle, both articulated and disarticulated human burials. Hal Saflieni, on several levels, was excavated and the Xaghra Stone Circle was a series of adapted natural caves. Both started to be occupied in the Zebbug period, immediately preceding the temple building period. They continued to be occupied until the end of the Tarxien period. Hal Saflieni was excavated, perhaps one should say emptied, in the early part of this century, with no adequate record except when Zammit took over the work. The Xaghra Stone Circle was cleared, but not completely, in the early part of the last century, but fortunately enough remained for some very useful data to be obtained in the new excavations of the 1980s and '90s.

Associated with the burials at the Xaghra Stone Circle were personal ornaments of beads, stone tools, pendants and pots filled with red ochre. The only grave goods associated with the Tarxien burials at the same site, were small terracotta, obese figurines of the type already described.

Both hypogea had ritual or cult areas associated with the burial areas. These were provided with altars, and it is in these areas, certainly at the Xaghra Stone Circle, that the bulk of the stone and ceramic figures and the pottery bowls were found. One Tarxien period bowl contained red ochre, a material that had been used to daub both figures and bones throughout the site's period of use. Most of the figures found were of the same form as those coming from temples, already described. At the Xaghra Stone Circle, two different types were found. One is a small limestone carving of a pair of pleated skirt obese figures, seated next to each other, one holding a bowl and the other what might be a child. The other different carvings found are a collection of nine stone figures, disposed when excavated in a way that suggested they may originally have been in an organic container, perhaps a sack or box, since perished. Six of the figures were flat, human figures about 15cms tall in various stages of completion, some adorned with pleated skirts. The other three were variously, a human head on a long neck, another on a V shaped support and the last an animal head on a long neck.

The whole of the Xaghra Stone Circle was originally surrounded by a stone wall – hence its name – with the entrance orientated towards the Ggantija temples, confirming a perhaps obvious connection.

2.7:3 LOCATION OF SITES

Fig. 2.13 shows the distribution of temple sites on the Maltese islands. The only feature that may be remarked on at this stage is the absence of any remains in the centre of Malta. The terrain is similar to that where temples are found, and whether the absence is a function of differential preservation or of original absence, is not known. The only domestic structures known are at Skorba, and at Ghajnsielem Road (near 9 on the map).

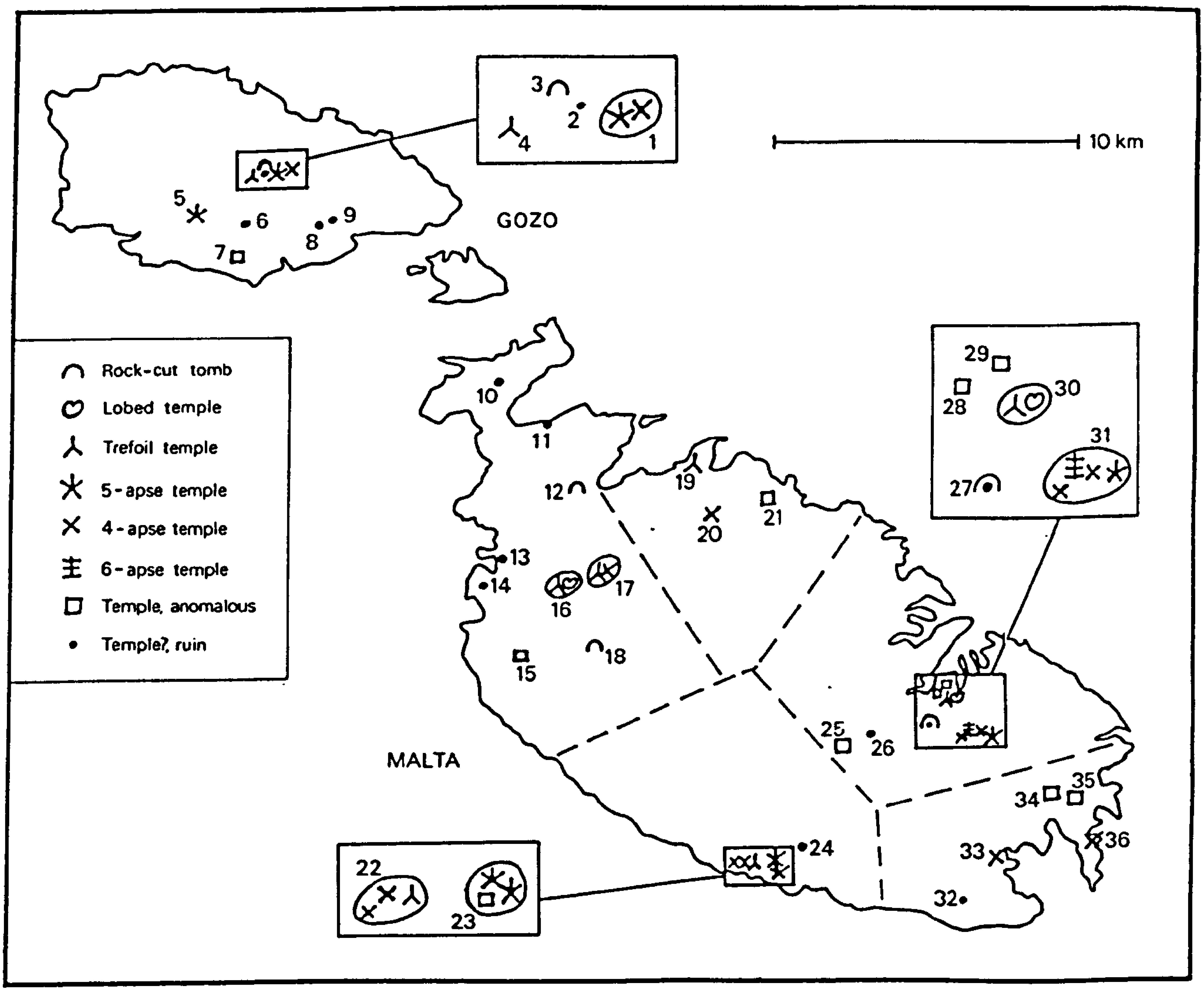


Fig. 2.13 The Distribution of Temple Sites on the Maltese Islands

27-31 are the cluster around Tarxien (31) and 27 is Hal Saflieni. 22 and 23 are Mnajdra and Hagar Qim, respectively. 17 is Skorba. 1-4 are on the Xaghra plateau, 1 being Ggantija. The Xaghra Stone Circle lies between 1 and 4 and it is not marked because its rediscovery post-dated the production of this map (Trump 1981). The dashed lines demarcate the territories proposed by Renfrew (1973 a).

2.7:4 SOCIAL STRUCTURE

Descriptions and explanations of prehistoric Maltese social structure are nearly as numerous as the scholars who have considered it. The literature consulted is listed in Appendix 3. Several things are clear from the foregoing description:

- The society was religious.

- Religion must have been well organised to produce the temples, the hypogea and their contents.

- Religion manifested itself regionally, without one dominant centre, but with a common ideology.

- Although religious manifestation changed over time, there were recurrent themes.

The question of population size is considered in detail in Chapter 7. Suffice it to say here that a reasonable estimate of its maximum size is about 10,000. Evans (1977 : 24) suggests that agricultural communities can double in size with each generation until the limits of land and other resources are reached. In the case of the Maltese islands, even with a small starting population, such a limit could be reached in a few hundred years; in fact in the first, Ghar Dalam, period. Many writers have speculated on whether the Maltese population grew to a point where relief was sought from the stress this caused, by engaging in temple building, and to what extent the effort required in such religious expression, exacerbated the stress, possibly leading to the ultimate downfall, and indeed extinction, of the Maltese temple building culture.

Before considering this matter further, it is worth reviewing the development of various aspects of Maltese temple building over time.

From their earliest manifestation through to their end in c2500 BC, the temples all had many similar characteristics. A differing number of inter-linking apses were surrounded by a peripheral wall, the intervening gaps being filled with rubble and earth, and the whole was fronted by a large platform. Access became increasingly circumscribed, this change taking place particularly in the Tarxien period. Either existing temples had screens of some kind erected to close off inner areas, such as happened at Skorba, or newly built temples had this feature incorporated. Bonanno, Gouder, Malone and Stoddart (1990) devised a series of access diagrams to show this development. Fig. 2.14 demonstrates the increasing complexity of access over time.

Concurrently with this change in access to temples, there came a change in the figures they contained. In all periods, obesity featured, but only grotesquely in the Tarxien period. Up to then, the sex of the figures could be clearly ascertained as female. While clearly female figures continued to be made in the Tarxien period, the very obese figures have no overtly sexual characteristics (unless it be said that large hips equals female). Biaggi (1986 : 137) suggests that: "The lack of sexual characteristics might represent the result of a process of evolution from figures whose power as sacred images lay in well defined sexual characteristics, to figures whose power lay in their opulence. The sex of the figures may have been deliberately left out to concentrate on the most important thing – the fatness and therefore the opulence and sanctity of the figures". She goes on to suggest that, like Medieval angels the similarities, rather than the dissimilarities between the sexes, were being emphasised. What of the continuance of clearly female terracotta figures, such as the "Venus of Malta"? Perhaps they represented the ministering priestesses.

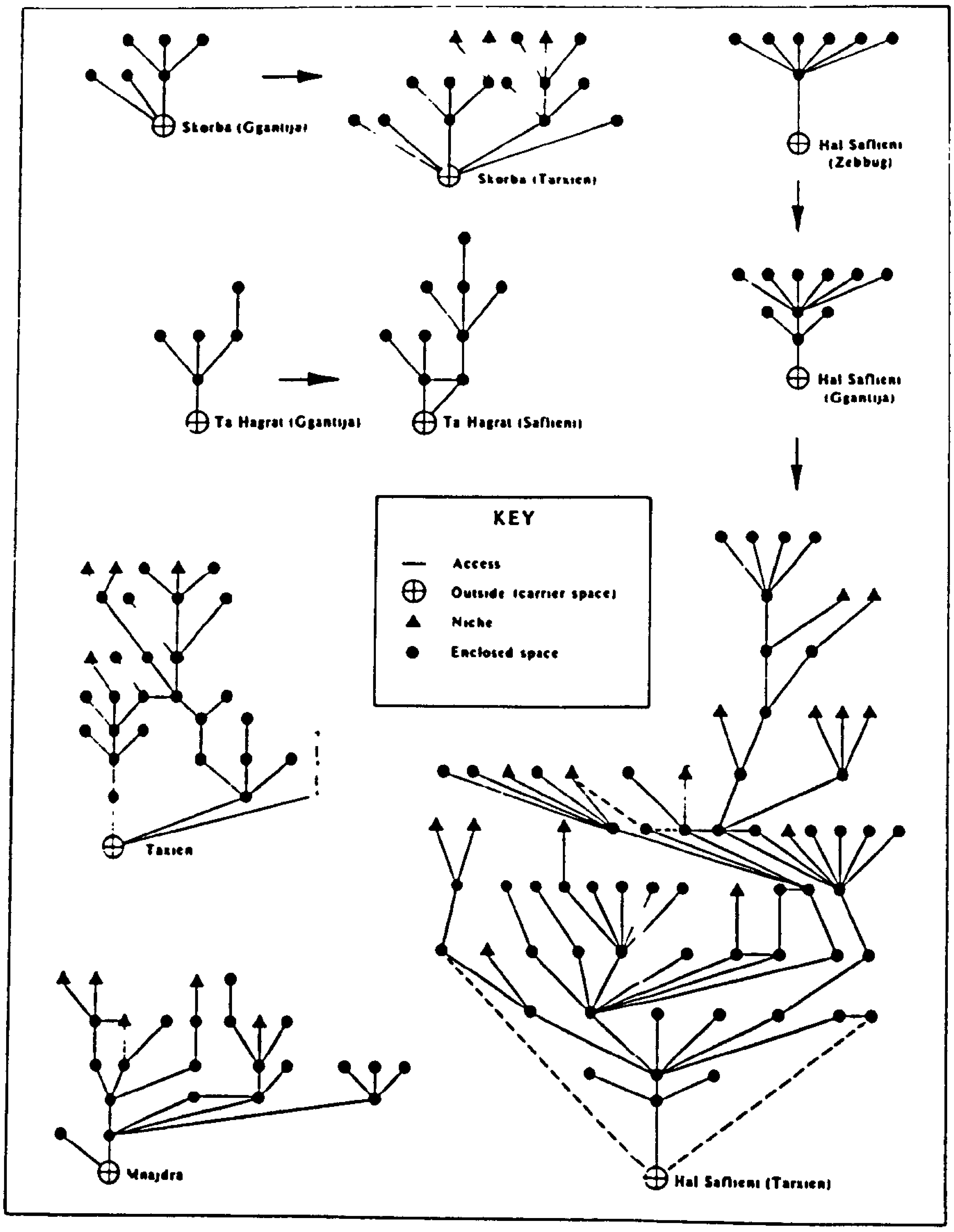


Fig. 2.14 Access diagrams for some Maltese temples and Hal Saflieni

The figures are often taken to represent some form of fertility cult. But at the same time, some cult of the dead, or of ancestors, must have existed because of the time and effort spent on constructing and furnishing the hypogea, with similar figures. Perhaps it was all one linked religious cosmos involving the perennial cycle of birth, life and death controlled by the gods (however envisaged), where propitiation was essential if that cycle was to continue. Perhaps the group of figures found at the Xaghra Stone Circle was the "tool kit" of some functionary involved in the ritual of such propitiation.

In noting the change in the form of the figures in the Tarxien period, the new feature of "puppet" heads on the obese figures, and of oracle openings, should be remembered. These too seem to add to the increasing aura of mystery and exclusiveness associated with more restricted access. There must have been a division between the initiated and the uninitiated: if <u>only</u> the initiated had access to the inner sanctum the rituals would have served little purpose.

The geographic distribution of the temples and the hypogea needs consideration. Fig 2.13 maps this distribution. Several facts may be noted.

- Temples are scattered all over the islands.

- There are at least three major complexes. The earliest, three lobed, temple types are found at each.

- Only on Gozo are there no Tarxien period temples. (Trump 1990 b, 26, 156; however the evidence is circumstantial, Trump 1998 personal communication). Nevertheless, internal furnishings of Ggantija and use of the Xaghra Stone Circle both indicate Tarxien period use.

- No one site is dominant, to any major degree, in terms of size.

- Only two hypogea are known.

This territorial distribution led Renfrew (1973 a) to suggest that Maltese society was divided up into a series of rival chiefdoms, Polynesian style, each with their own territory needing demarcation and aggrandisement, but sharing a common ideology. The six such territories Renfrew proposed are shown on Fig. 2.13. Polynesian chiefdoms are based on a lineage based status structure and Renfrew (*op. cit.*) develops the notion of such a structure as a model for Maltese society, and goes on to consider the similarities between Maltese and Easter Island societies and their development. In another paper, Renfrew and Level (1979) further explored Maltese territoriality using the Xtent modelling technique. This technique weights Thiessen polygons (the ones Renfrew used in Fig. 2.13) so that territorial area is dependent on the size of centre. The more weight given to the importance of size of centre, the fewer such centres will appear until in the end a picture of dominance will arise. Applying the technique to Malta by measuring the size of the various temple clusters, Renfrew and Level found that with a low centre size weighting, they arrived at the same six territory division as Renfrew had originally proposed. With the highest centre size weighting, they arrived at just two centres, based on Tarxien and Ggantija respectively.

Bonanno, Gouder, Malone and Stoddart (1990 : 192-5) criticise "the underlying assumption behind previous interpretation of the Maltese monuments - - - of an increasingly centralised hierarchy that could not be sustained and led to collapse," on two grounds. It is not clear to what "previous interpretation" they refer unless it be to Renfrew and Level's two centre Xtent model. They do however make two useful points. The first is to question the appropriateness of the (Polynesian) chiefdom model to [all] "middle range societies", "that is those societies on the gradient between simple agriculturalists and states". The second is to draw attention to the fact that Maltese temples typically appear in pairs, or larger groups. This, they say, would indicate fluctuating cycles of intra-group competition as well as inter-group rivalry, promoted by prominent individuals operating in the dense social networks of a relatively small population, recruiting and using their personal factions within a similar ideological context. The author's view of these two points is firstly to agree that too blind a use of Polynesian ethnography would be wrong. On the second there seems no justification for postulating intra-group competition as the explanation for the clustering of temples. Indeed where there are pairs of temples abutting the later of the two is inferior in execution to the earlier one. At Ggantija the re-use of some of the stones from the first temple's perimeter wall to construct the new perimeter wall around the pair of temples, would seem to indicate co-operation not competition. This problem is further discussed in Chapter 9.

It is however, worth noting that only two hypogea are known, and these are at Renfrew and Level's maximum dominance centres. Many have supposed that there must have been a further hypogeum at the Hagar Qim/Mnajdra site, but none has yet been found. Perhaps the two centres postulated by Renfrew and Level were accepted by Maltese society as far as the functions of hypogea were concerned.

There is a further problem about the chiefdom model. Chiefdoms tend to defend their territories and to expand them by means of warfare. No Maltese temple period weapons have been found other than a very limited number of worked flints and sling-stones, more probably used for hunting than for warfare. It could of course be that weapons were fashioned from now perished organic materials, but this seems unlikely for techniques of warfare are always advanced by technological developments of weapons. It seems therefore that the rivalries inherent in any society were worked out by other means by the Maltese.

Were there environmental or ecological changes during the temple period? Although suggested by several authors, there is no hard evidence that temple building society, or its predecessors, caused major environmental damage such as deforestation and soil erosion. There is evidence that such damage had occurred by the late Bronze Age c1000 BC, (see Chapter 5, section 5.4:1), but there is no evidence that it occurred before or during the temple period. Indeed, the skeletal evidence from the Xaghra Stone Circle indicated very healthy individuals. (Malone, Bonanno, Gouder, Stoddart and Trump 1993 : 81).

Many authors refer to stress caused by over-population or environmental degradation or a combination of these, and by the effort being put into temple building. For example: Trump (1990 b: 21): "Excessive temple building might imply neglect of the precious soil of the fields". Malone and colleagues (1993 : 83): "[by 3000 BC] Malta seems to have become an island world under powerful economic and environmental stress, where the communities were struggling to maintain their former standards of living and to feed the population."

Stoddart and colleagues (1993 : 8): "- - - late Tarxien society can be envisaged as stressed and isolated, preoccupied with its own predicament - - -".

Evans (1977 : 23): "Eventually the time and effort demanded [to build the temples] must have come near to straining the capabilities of the population to the utmost limit, and the resulting strains may even have assisted in bringing about the eventual breakdown of the system".

Renfrew (1970 : 208-9) asked: "Should we regard the temples of Malta - -- as fantastic material achievements - - - absorbing much of the time of the population and perhaps seriously hampering development in other directions - - -? Or did they represent a relatively small annual effort - - - a small tax upon the population - - -?".

It is this question that the balance of this research addresses. The next chapter describes the rationale of an energetics approach. That is a methodical assessment of the labour input, over time, into a monumental construction and what conclusions about societies' structure and development may be drawn from such an analysis.

2.8 THE POST-TEMPLE BUILDING PERIOD

The temple building period ended in about 2500 BC. It was succeeded by the Bronze Age Tarxien Cemetery period. It is so called, rather confusingly, because the type site was a cemetery used for the interment of the cremated remains of these Bronze Age people in a sterile soil overlay, above the Tarxien temples. This might be taken as indicating a hiatus between the end of the Tarxien period and the beginning of the Tarxien cemetery period. On the other hand, the Tarxien Cemetery Bronze Age people may have colonised the Maltese islands in about 2500 BC and either annihilated or assimilated to their culture any pre-Bronze Age people they found. What is clear is that there was a new immigration, whence is not entirely clear, bringing with them new pottery, metal weapons and a total disinterest in the temples which were abandoned. (It is worth noting the absence of any weapons before the advent of the Tarxien Cemetery period, there are no spearheads and only one arrow head from Tarxien and two from Ggantija. The latter may have been for hunting as may some objects found in the Hal Saflieni hypogeum possibly identified as slingstones.) (Evans : 1959, Trump 1990 b.)

CHAPTER 3

THE RATIONALE OF AN ENERGETICS APPROACH

3.1 INTRODUCTION

This chapter sets out to:-

1. Define energetics: that is, what is meant by the word in an archaeological context.

2. Suggest what we may hope to gain from its use in an archaeological context.

3. Comment on the history of the use of energetics analyses in archaeological contexts.

4. Consider some examples of the application of energetics in archaeological contexts, the problems involved and the uncertainties resulting.

5. Consider the utility of an energetics approach to the Maltese temple period.

3.2 DEFINITION OF ENERGETICS IN AN ARCHAEOLOGICAL CONTEXT

Energetics is the study and evaluation of the energy expended in producing something. In terms of prehistoric architecture, it is to assess the amount of energy involved in constructing an edifice. Such energy expenditure may usefully be measured in person-hours or person-days.

What makes such a study worthwhile? Abrams (1989 : 53) says: "The explicit goals of the energetic analysis of architecture are to explain ... the cultural context that led to the particular pattern of energy expenditure and distribution, and to describe and explain the process of changing energy expenditure in architecture through time".

The energetics analysis itself comprises estimating the energy in terms of labour, which went into the construction of a monument or suite of monuments. It is necessary to consider whether the monument was built in one stage, or several, and if the latter, to consider the energetics of each. The monument, or each of its stages, will need to be theoretically reconstructed to its original form. Both the phasing and the reconstruction may present significant problems in an archaeological context.

The components of an energetics analysis are theoretically straightforward and consist of two elements. The first is to evaluate each stage of the monument in question (in its theoretically reconstructed form) in terms of the quantity and size and degree of preparation of its various constituents. For example, the stones of its walls, the plaster of its surfacing, the painting of the latter. The second component of the analysis is concerned with estimating the energetics involved in the procurement, transportation, preparation and erection/use of each of these constituents.

A sub-sector of any such analysis is the consideration of any specialist skills involved in such an endeavour, that, for example, involving sculptors, ceramicists, wall painters. The use of such specialists may throw light on the cultural organisation of the society involved.

In addition to the points discussed above, there are other inputs, which will add to any light thrown on the cultural context. The first is to estimate the duration of each construction stage. As will be seen in the examples discussed below, useful data on construction data are sometimes available, eg. for Egyptian and Mesoamerican Mayan constructions. In the absence of such historical data, such estimation is likely to be impossible. The second is estimation of the size of the population geographically available for the work involved, if any reasonable estimate of the demands on that population is to be made. Various methods may be employed to this end. If archaeological evidence for residential sites and their size is available, this is clearly useful. Carrying capacity of the land, using prehistorically available technology, and historical records will provide further evidence. Thirdly, in addition to the total energetics involved, particularly in transportation and erection, the maximum size of single monoliths may predicate a minimum work force.

Estimation of these elements, combined with the complexity of the monument concerned, will give an indication of the social organisation required, and perhaps of the strain which building the monument, placed on society. In addition, as the quotation from Abrams above suggests, if there are distinct building phases with changing energy expenditure or architecture, or building contents, changes in social organisation may be indicated.

There is a general recognition that there is some correlation between the scale of monumental building and social complexity. It is equally recognised that one example of monumental building of a certain scale with a particular social complexity associated with it, does not mean that another culture, with a similar scale of building, has a like social complexity (and of course vice versa). This does not however mean that an energetics analysis cannot contribute to an assessment of the degree and form of social complexity, and its development over time. In relation to the form of complexity, McGuire (1983, see also Rathje 1975, Abrams 1989), makes an important point in distinguishing between inequality and heterogeneity. Inequality is the variable of wealth differences, whereas heterogeneity is concerned with the degree of functional differentiation such as power or the existence of a priesthood. "These two variables specify the vertical and horizontal axes of social structure, and their interaction defines the form of any given society. Considering how these interrelationships change, produces an evolutionary model of social structure" (McGuire *op. cit.* 93). The two variables of inequality and heterogeneity may not increase in step in a situation of developing complexity. Frequently, heterogeneity may increase – say with some form of social power structure becoming able to organise the building of public monuments in a relatively egalitarian society; which power structure, once in place, then turns to increasing its relative wealth, thus increasing inequality, which may evidence itself in varying opulence of residences or of burials. As we shall see, for the Maltese temple building period, that society appears to have continued for a thousand years in the first phase; temples continued to be built but there are no residential or significant burial signs of increasing inequality.

3.3 HISTORY OF THE USE OF ENERGETICS IN ARCHAEOLOGICAL CONTEXTS

This section gives a brief history of the use of energetics in an archaeological context. It is of comparatively recent origin. During the first half of this century, and indeed before that, architectural studies were concerned with detailed description, and archaeological excavations were directed to that end. At the end of this period, such studies also embraced the attempt to identify the unilineal stages of cultural development, exemplified by successive monument construction. This position changed in the mid 1960's.

Kaplan (1963) and Cowgill (1964) were concerned to argue against the widely held view that when large amounts of labour and specialist craftsmen were needed, this could only result from the threat or use of coercive force. Kaplan (*op. cit.* 397) for instance states: "One of the prominent themes running through recent comparative work on ancient state – or state-like – societies, has been the relationship between the construction and maintenance of large-scale public works and the emergence of centralised bureaucratic political systems". And again, (*op cit.* 399) he quotes A. Palerm as saying in 1955: "Actually a strong socio-political organisation seems to be the only way open to a people with a poorly developed technology to have and use large-scale public works. Human labor is the only substitute for advanced technology; the less technology the more human effort is required, which means greater coercive organisation - - - How can one mobilise such crowds, make them work in organised fashion and maintain them without a powerful and efficient social structure?" Kaplan goes on to say himself: "the author's argument often tends to shift from a functional to a causal level and becomes deceptively circular: a powerful centralised bureaucratic state is required to build large scale public works, and the construction of such works leads to the emergence of a coercive centralised state."

However, the arguments of both Kaplan and Cowgill were couched in rather general terms and were concerned to point out that traditional agricultural efficiency was such as to have considerable surplus labour available. As Erasmus (1965 : 280) says, it is not justifiable to lead from this to a "picture of bored aboriginals wandering aimlessly through the brush [*sic*] in search of a power structure to put them to work".

Kaplan and Cowgill and Erasmus were all concerned to point to examples around the world, where large monuments are the result of uncoerced community effort and typically are religious monuments, built out of a desire for community prestige and cohesiveness, often over long periods of time.

Kaplan argued that even some of the largest Mesoamerican monuments could have been made over protracted periods of time, by part time workmen operating under a developed chiefdom-type society, rather than under a coercive state system. Erasmus, (1965) undertook a pioneering energetics study at the Mayan ceremonial centre at Uxmal, Yucatan, Mexico. By experiment, he derived data to cover the labour per unit involved in the extraction, transport, preparation and erection of the materials involved in the construction of the centre. Based on measurement of the centre and the quantified use of the various components of its construction, he calculated the amount of labour building it had required, including that of any specialist craftsmen such as sculptors. He then assessed how much labour would have been available. He went on to make the critical assumption that the labour to construct the centre was expended uniformly over the historically attested 250 years of occupation. The consequences, in terms of the strain on the community building the centre, are discussed in more detail in section 3.4:1 below, but in summary, his conclusions were that the degree of strain was by no means so great as to imply that coercive force was employed.

Sanders and Price (1968) did not like the conclusions of Kaplan (1963) and Erasmus (1965) (nor for that matter, by inference, Cowgill (1964), though they do not cite him). They say: "A major problem is attempting to infer reliably, the distinction between chiefdoms and civilisations from the archaeological evidence. ... The difficulties lie in seeing the distinction between unusually large chiefdoms and non-urban civilizations in the archaeological picture." (*op. cit.* 53).

Sanders and Price argue that if there are no preceding, or succeeding, analogues for a population of 1,200 households building a centre the size of Uxmal, then it is unlikely that Uxmal was so built, and they find no such analogues. Indeed, post contact Mesoamerica, with all its religious fervour, and with corvee labour available, could manage no equivalent. "The question is not what <u>can</u> be done, but what is <u>normally</u> done by organised groups of humans in the way of co-operative building projects". (*op. cit.* 55) They further say that most major Mesoamerican sites are at the centre of an area of several thousand square miles with peripheral smaller centres, though without adducing the same situation for Uxmal. But it is of interest that later in their book, (*op. cit.*131 *et. seq.*) they observe that: "the historic distributions of chiefdoms coincided with regions composed of small, circumscribed, microgeographical zones". That is, islands or circumscribed mainland areas. Where there was an agriculturally fertile area, surrounded by less fertile territory, the surplus produced by the fertile area allowed a lineage of chiefs to develop increasing hegemony over an increasingly large area.

Undeterred by such criticism, Abrams (1984 a, 1984 b, 1987, 1989), undertook energetics analysis at the major Mayan site at Copan Honduras. He was concerned with the energetics involved in residences rather than public monuments, and with what light such an analysis could throw on the structure of society and the means by which it mobilised the necessary labour. To make the analysis, he both used the data Erasmus had derived and supplemented it with his own experimentation. He came to a number of conclusions:

- there was marked inequality in Late Classic Mayan society with a palace residence requiring several thousand-fold the labour input involved in a humble residence,

- even such a large residence did not put a major strain on the society that built it,

- which fact did not of itself preclude the use of some form of corvee labour or slaves – say war captives. ("Corvee" in the sense of "the practice or an instance of forced labour": Collins English Dictionary).

The second of these conclusions is very similar to that of Erasmus outlined above. Abrams' work is covered in more detail, later in this section. The studies of Erasmus and Abrams were not concerned with development over time. Such work was done by Cheek (1986) also at Copan and by Kolb (1994) in Hawaii (see sections 3.4:1 and 3.4:2). By evaluating the variation in size and in the case of Kolb, in function, these both traced the variation in labour input to monument construction over time, and from such data, speculated on the changing nature of the societies involved.

It is of interest that Earle (1994) commenting on Kolb's work, says (535): "During the 1960 and '70s, studies of labor contributions to monumental construction gained an unsavory reputation because of problems with measurement and interpretation. But with innovative reconsideration a new generation of archaeologists represented here by Kolb is returning to labor as a critical dimension for measurement. Fundamental to meaning is an understanding of value, and a labor theory of value, ... offers an obvious opportunity for archaeological research. ... Kolb is able to measure the changing human investment of labor in monumental construction as articulated with concomitant changes in social and political organization. Labor has the virtue of offering a common currency for investigation of the nature of social action and meaning from the individual object to the monumental pyramid."

Kolb's work is commented on in more detail below. It may be noted that Kolb's work and also that of Webster (1991), considering Sardinian nuraghi discussed later in this chapter, drew heavily on the pioneering experimental work of Erasmus and Abrams, as indeed does the author's.

It is interesting how little use of the technique of energetics analysis has been made in recent years. From the foregoing, and from the more detailed review that follows, it would appear that energetics analyses can make a significant contribution to understanding past societies and their development. And yet, to the best of the author's knowledge, only Webster (1991) and Kolb (1996) have made use of it. It cannot be that there are not subjects fit for such study – for example in South America.

The remainder of this chapter considers those examples where energetics analyses have been applied.

3.4 REVIEW OF EXAMPLES OF ENERGETICS ANALYSIS

Brief mention has been made of several energetics analyses in the section above. This section considers them in greater detail.

3.4:1 Mesoamerica

Erasmus (1965) worked at Uxmal (see above). By experiment, he derived data for the procurement, transport, preparation and construction of the materials involved in Uxmal. This came to a total of 7.5 million man-days. Erasmus says Uxmal was occupied for 250 years and assumes it was built uniformly over this period, giving a figure of 30,000 man-days per annum.

Erasmus goes on to consider relevant population densities. He concludes that 75 persons, or 15 households, per square mile, is a reasonable figure. Taking a five mile radius around Uxmal (two hours walking) gives a total of 6,000 persons or 1,200 families.

Assuming each household provides the occasional labour of one man, if Uxmal was built uniformly over 250 years, this would require 27 man-days per annum per household. As a figure double this would not be unreasonable for uncoerced labour (roughly one day per week, per household), there is considerable scope for variation in building activity over the years. And as Erasmus says (*op. cit.* 297) "with a little enthusiasm" spurts in building activity could have achieved the "Nunnery Quadrangle", the largest building complex built to one pre-conceived plan, in six years or so.

Erasmus (*op.cit.* Fig. 1) produces a graph showing the relation of annual household and community corvee labour costs at different population densities (Fig. 3.1 below).

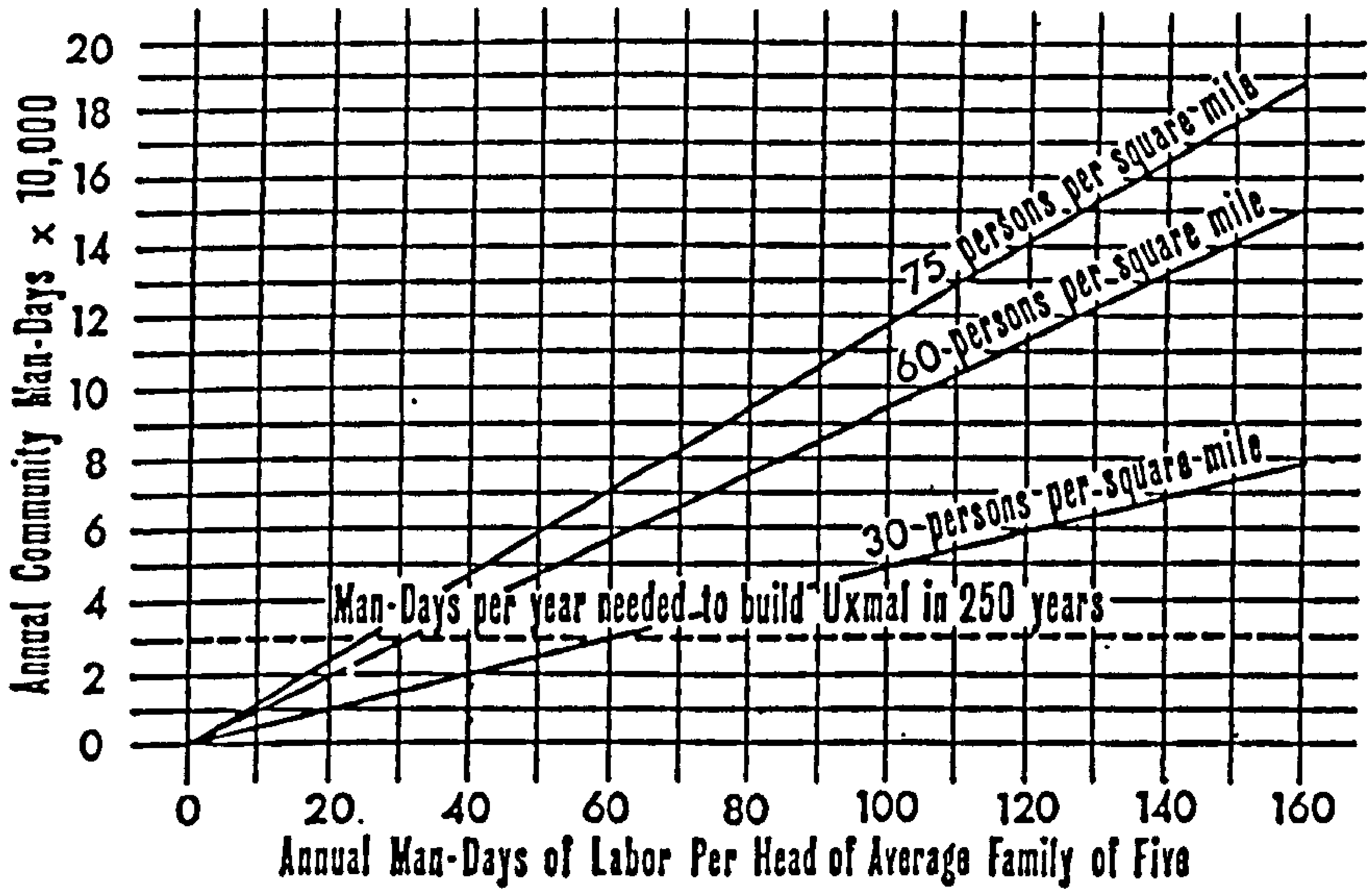


Fig. 3.1 Relation of annual household and community corvee labour costs at different population densities.

On various evidence, he suggests that in agriculturally productive areas, it is no hardship for a man to discharge his duties to his chief or community, by "giving" 40-50 man-days per annum. Corvee labour demanded variously by feudal English lords or the owners of Bolivian haciendas earlier in this century, could amount to "a third, to a half of a man's year". (*op.cit* 281). Demands of this size in both cases could give rise to revolutionary flare-ups and to suppression by military force, ie. a state reaction.

In both these examples, it was the man of the household who provided the labour. The extreme case quoted by Erasmus, is that of post World War II Ukrainian collective farms, where 500 person-days per annum, per household, were demanded by the state. This was extreme coercion by one of the most coercive of modern states.

This 40-150-500 series, gives some measure of the degree of the centralisation of power, and it is to this measurement that energetics can contribute.

Erasmus goes on to consider the problems of planning and co-ordination. He suggests that "Maya society [was] an unusual member of the chiefdom class", (*op. cit.* 297) involving a priesthood sub-culture, capable of such planning and co-ordination. In support of this argument, he suggests firstly that Mayan murals do not support the idea of a repressive authority: while there is evidence of rank, all ranks seem to have easy inter-relationships. Secondly, he suggests that one must remember that chiefdom societies that might have been more elaborate socially and culturally, would be just those most likely to be eclipsed by stronger colonising states, because their very elaboration posed the most threat to the colonisers.

Another piece of major energetics work in Mesoamerica was that done by Abrams (1984 a, 1984 b, 1987, 1989) at Copan, Honduras, a major Mayan site. Like Erasmus, discussed above, Abrams was concerned to use energetics as a means to suggest the social organisation of its builders. He did extensive experimental work to determine the labour content involved in procurement, transportation, processing and erection of the materials involved, in a selection of edifices. Further, he divided these inputs into those of specialists (preparation of plaster, sculpturing and construction, including planning and supervision) and unskilled labour (all other activities).

His conclusions were that the following person-days were required for (1989 : 72):

Rural wattle and daub house	50 P.Ds. to 100 P.Ds.
Masonry urban residences	1,000 P.Ds. to 5,000 P.Ds.
Royal palace	30,000 P.Ds.

All the urban compounds, with the exception of the royal palace, were similar in having several residences that had required 1,000 P.Ds., and one, or a very few, that had required 5,000 P.Ds.

Abrams tackles the problem of time by suggesting that a standardised time of 60 days be allowed for each structure. Thus allowing them to be built in the slack farming season, a practice having much ethnographical support (1989 : 66-7). He calculates that the larger residences would require 17 persons, the largest non-royal residence 137, and the palace 40 specialists and 371 non-specialists (1989 : 73).

Abrams estimates the population of the Copan "pocket" to be 12,000. That is a labour pool of 4,000. To build the palace in 60 days, required 371 non-specialists, ie. 9% of the pool. If built over one year, this becomes 1.5%. And such requirements would be occasional.

As far as specialists are concerned, Abrams suggests that master-specialists might have been members of the rulers' lineage, who could be supplemented when necessary by using the specialists of the lesser lineage chiefs. Specialists who might themselves, be part time. Such use could depend either on the ruler having political power, or through his having established obligations through gifts and feasts.

The same way of organising the necessary unskilled labour would apply. The intermediate elite would operate a similar system of recruitment within their sub-division of the social group. The commoner would draw on his own familial network.

The conclusion Abrams drew in 1987 (496) was: "that elite construction was not a drain on the labour pool, and that elite construction demands created little, if any, stress on the infrastructure of Late Classic Copan society." But in 1989 (73), based on the same energetics analysis, he says: "These figures suggest a model of hierarchical labor recruitment, the ruler able to recruit from the entire polity, possibly within the context of a form of corvee system". The two statements are not incompatible of course, but the second throws rather a different light on the Mayan society than the first taken in isolation – an instance perhaps of one of the uncertainties an energetics analysis cannot solve.

In passing, it may be noted that the Chiefdom/State argument about Mayan society continues: See, for example, Fox, Cook, Chase & Chase 1996, Chase & Chase 1996, Fox & Cook 1996 and Demarest 1996. While taking differing views, these all agree that there was considerable diversity of Mayan social organisation, and further that it should be recognised that there were intermediate stages between the two, which they call segmentary. This would seem to fit quite nicely with Erasmus' and Abrams' conclusions. The unifying force within such a system might be a theocratic, not a political one.

All the work we have reviewed so far, has been concerned with taking a snapshot at a particular moment in time. In Mesoamerica, energetics has also been used to illuminate societal changes over time and I briefly review the work that was done by Cheek (1986). Without attempting to quantify the energetics involved, he analyses the number and volume of the structures built in the Main Plaza at Copan, Honduras. Using electrical resistivity over the whole area, he mapped the structures and did trial excavations of those areas not previously excavated. Using existing structures as analogues for those structures only partially remaining or overbuilt, he estimated the volume of each structure. Then by allocating both the numbers of structures and their volumes to their respective time periods, (corresponding to the classic sub-divisions of Mayan culture) he plotted the changes in constructional activity in each period.

This showed significant variations, and one of the conclusions he arrives at is that despite the increasing population in the Late Classic: "the rulers at Copan seem to have increased the tax burden on their peasant populations. Whether this was sufficient to cause them excessive stress, will not be known until actual labour expenditure and final population figures are known". (op. cit. 67)

Although inconclusive, this work does have useful pointers to the use of energetics to demonstrate the changes in the demand for labour over time

3.4:2 Energetics Analysis in Hawaii

Following on the discussion of Cheek's work above, it is appropriate to consider work done by Kolb (1994) on Hawaii, which follows a somewhat similar methodology.

Eight temples on the island of Maui were excavated and the forms of their construction were allocated to each of the recognised periods of Hawaiian societal development (Formation, Consolidation, Unification and Annexation), when a temple of the relevant period was present. The number of person-days involved in the construction of each stage, in each temple, was computed by using the experimental data of Abrams (1984 a, 1989), Erasmus (1965), Renfrew (1973 c) among others. (Details of such data are given in Chapter 4.)

The other significant data extracted during excavation, were the numbers of identifiable specimens of faunal remains. These were taken as "indicators of conspicuous consumption". (op. cit. 526).

Finally, the design of the various stages of temple construction were assessed, with the resultant conclusion that design moved from open (ie. accessible to all) to closed (ie.

restricted access) over time; that open access small temples, theocratically built for all, grew in size (and labour input) as chiefs took to themselves, religious as well as political power; that access became more exclusive and finally that constructional activity declined, as sacrificial activity increased (a labour tax changing to one of in kind). As Kolb puts it: "[This] documents the increasing role of the chief as intermediary with the supernatural. Intensification of the religious role of elites, is a common pattern in complex societies. Early in the course of political development ... large public monuments were constructed to bind elite and commoners together in a common ideology. ... [later] elites began stressing their role as mediators with the supernatural ... enhancing their status through displays of material wealth." (*op. cit.* 533)

This quotation of some length has been given because it may be relevant to the Maltese situation.

3.4:3 Energetics Work on Neolithic and Bronze Age Wessex

This is of particular interest in relation to Malta because, unlike the situation in Mesoamerica, procurement, transport and erection of megaliths is involved.

Work on the Neolithic has been done by Renfrew (1973 b, 1973 c), Atkinson (1961), Wainwright (1969), Startin & Bradley (1981), Richards & Whitby (1997), and Scourse (1997), among others. Most of the interest from our point of view, arises from the experimental work with megaliths, but in addition, one may note particularly the work of Renfrew (depending on the earlier work of Atkinson (1961)), and of Startin & Bradley (1981), both of whom calculate the labour input into earthworks. Renfrew (1973 c), sees a progression from 10,000 man hours for a long barrow, to 10,000,000 man hours for eg. Silbury Hill. He deduces increasing development of chiefdoms with a core/periphery structure. He discusses population density but does not attempt the concomitant calculation of what sort of strain construction activity put on society.

Startin & Bradley (1981), recalculate earth work labour requirements at a much lower figure than Renfrew, and conclude "monument building in Wessex need not have made an enormous demand on the energy budget". (*op. cit.* 294). They base this conclusion on the construction of Bronze Age Avebury or Stonehenge, requiring the labour of 1% to 5% of the population, depending on whether one assumes those involved came from Wessex as a whole, 50,000 persons, or the Marlborough Downs, 10,000. Startin & Bradley are ambivalent about whether their data points to Renfrew's "continuous evolution"; they prefer, on the whole, to see a jump change between Neolithic and Bronze Age. (op. cit. 294).

3.4:4 Energetics Work on Sardinia

Webster (1991), considers the energetics and concomitant social implications of Bronze Age, Sardinian nuraghi. Webster suggests that in village settlements of about forty, the nuraghe served as the fortified refuge for all and the residence of the local petty-elite. Architecturally, the classic nuraghe is a stone constructed, truncated cone with internal rooms. This form became larger and more complex over time. Over 7,000 nuraghi are scattered throughout Sardinia.

Webster used energetics data from Erasmus (1965) and Abrams (1984 a) to calculate the labour input into various sizes of nuraghe. Along with the increasing size of nuraghi, the population and settlement size was also increasing. Thus, over the whole nuraghe building phase of 1,200 years, at no time would adult males be called on to contribute more than 40 days per year, if plausible construction time estimates are used. (A classic nuraghe needed

3,600 person-days, the largest 18,000.)

Webster was concerned to throw light on the argument between those who held that nuraghi were built by a complex society, employing both specialists (architects, etc.) and slaves (eg. Balmuth 1981, 1984, Gallin 1987, Lillin 1959) and those who held that uncoerced, communal labour from petty-chiefdoms, was used, (eg. Trump 1980, 1990 b, Santillo-Frizell 1989). Webster concludes by confirming his initial assumptions: the data pointed to the use of uncoerced labour from a petty-chiefdom type society.

3.4:5 Easter Island

There is no overall application of energetics analysis to Easter Island. Much work, including experimental work, has been done on the labour requirements involved in quarrying, carving, transporting and erecting Easter Island platforms and statues (Bahn & Fenley 1992, Heyerdahl 1958, 1961, 1989, Heyerdahl & Ferdon 1961, Lee 1986, 1992, Sahlins 1955, Fischer 1993, Flenley 1993 amongst others). But all these estimates and experiments were concerned with the labour content involved with particular statues, and do not go on to estimate the percentage demand on the available labour force. Van Tilburg 1994, goes further in estimating the labour and time involved in moving an average statue, (upwards of 70 men from a total of 400 persons), and estimates the amount of surplus resources required to support this effort, and concludes that something like double the normal agricultural subsistence resources, was required. However, as Van Tilburg estimates a period of five days for this work, it is too short in duration to provide any pointers to social or economic impact.

Of more interest is the assessment of environmental degradation on Easter Island. Evidence derives from palynologic, palaeozoologic, native tradition and historic records.

A picture of ecological degradation emerges from a variety of causes such as deforestation (trees being used for various purposes and their regeneration being inhibited by imported Polynesian rats eating their nuts), soil erosion, shortage of protein, (no timber to build boats to catch fish, etc.). Population estimates are for a drop in the total, from c.10,000 to c.2,000 before the calamitous Peruvian slave raids in the 1860's (Van Tilburg 1994, Bahn & Flenley 1992, Lee 1986, 1992, Flenley 1993).

This evidence of ecological degradation is of particular interest, because of its possible relevance to the situation in the Maltese temple Period: are there parallels of over-exploitation of resources on a similar sized island, with a similar sized population?

3.5 THE UTILITY OF AN ENERGETICS APPROACH TO THE MALTESE TEMPLE PERIOD

The remains of the Maltese temple Period have been briefly described in Chapter 2.

There is a number of "temples" on Malta and Gozo, often in pairs, distributed in such a way as to suggest to Renfrew (1973 a), that they were built as chiefdom markers of particular territories. The temple period lasted for some 1,100 years (3,600-2,500 BC), with temples being built in both the first half (the Ggantija phase) and the second half (the Tarxien phase). These dates are calibrated c.14 based, see for example, Renfrew 1972 : 144. The temples appear to have been for ritual use for the living – there are no signs of burials. Additionally, two subterranean hypogea are known, associated in each case with a temple complex, which combined the functions of burial places with, apparently, ritual facilities for the dead or their veneration. Apart from one, or at most two, sites of housing complexes, there are no known residential structures associated with the temples.

In terms of existing monumental remains, there are four sites where temple remains allow reasonably plausible reconstruction of their original form: Mnajdra, Hagar Qim and Tarxien on Malta and Ggantija on Gozo. Only at Tarxien is there any reasonably scientific excavation evidence: the other three sites have larger remaining edifices but they were "cleared" in the earlier nineteenth century before systematic archaeology was developed. The evidence from Tarxien will be useful when considering the original form of the temples, especially the vexed question of roofing.

Three sites have considerable upstanding remains of, in each case, a pair of adjoining temples. There are the twin sites, less than a kilometre apart, of Mnajdra and Hagar Qim. The former lies on Coralline limestone and is built partly of that material and partly of Globigerina limestone, which is available near by. At least one of the Mnajdra pair of temples appears to have been built earlier than those at Hagar Qim, which are constructed of the Globigerina limestone on which they lie. (In passing, it may be noted that the South Temple at Hagar Qim, as it now stands, is a complex structure, not easily falling into the single entrance, multi-apse form of most other Maltese temples.) The most complete structure, with some walls still standing to a height of seven metres, is Ggantija on Gozo, built in the main, of the local Coralline limestone on which it stands. It is near Ggantija that the hypogeum, known as the Xaghra Stone Circle, is sited.

The use of energetics analysis to throw light on socio-economic complexity requires, for its fullest utility, an ability to assess the following:

1. A meaningful reconstruction of the monument being studied.

2. An assessment of the time over which it was constructed, and if in phases, how long each lasted.

3. The labour input to its construction (phased if that were the case).

4. The input of specialists if they were involved.

5. The labour available for construction.

How susceptible is the Maltese temple period to such an analysis?

Taking one temple complex, that of Ggantija on Gozo, it can be said:

1. A meaningful reconstruction is possible.

2. The construction can be phased into three parts. The time of construction of each can only be guessed at, but may be relatively irrelevant if labour input is low, in relation to labour available.

3. Labour input can be calculated with fair accuracy.

4. Specialist input can also be calculated with fair accuracy.

5. Labour available can only be estimated by reference to prehistoric carrying capacity and likely land utilization, and to historic data.

Although there are two considerable uncertainties in the list above (that of construction time and population available), the conclusion is that an energetics analysis may well illuminate aspects of the Maltese temple building period society. Ggantija has the most complete, extant remains and stands alone, as the major temple complex on Gozo, and for these reasons, has been chosen as the site for a detailed energetics analysis.

It may be asked: has this been done already? Pollini (1988) made an estimate in some detail, of the labour input into the temples of Tarxien, Hagar Qim and Ggantija. Neither he nor his colleagues (Anati & Anati 1988), extend the analysis to consider the other variables listed above. The validity of Pollini's work will be considered after the author's analysis.

The next chapter is concerned with the attempt to reconstruct the original form of Ggantija and its phasing.

CHAPTER 4

THE GGANTIJA TEMPLES : ORIGINAL APPEARANCE AND MATERIALS

This chapter, after a brief introduction to the temples on the island of Gozo, assesses the original appearance of the Ggantija temples and the phasing of their construction. The amount of materials used, is calculated for use in the energetics analysis in Chapter 6.

4.1 THE TEMPLES ON GOZO

On Gozo there are three known temple sites. Ta Cenc is on a plateau, on the south centre of the island and is otherwise known as Borg li Mramma (Trump 1990 b) or Il Borg ta l'Mramma (Evans 1971). It is of uncertain date, very small and ruinous. The other two are in the north centre of the island on the Xaghra plateau. The first is Santa Verna, a small temple site, and as far as the few remains allow determination, a site in use throughout the prehistoric period (Evans 1971 : 189). Santa Verna is just less than a kilometre away from Ggantija, the major temple site on Gozo.

4.2 THE GGANTIJA TEMPLES : Brief Description

Ggantija, or the "Giant's Tower", is on a quite different scale from the other two temples and comparable to the large ones on Malta.

It is a double temple site, both temples being built in the Ggantija phase (c.3600-3000 BC). The first and older one on the south west of the site, hereinafter the 'South Temple', is a five apse temple and the later one, a four apse temple on the north east, hereinafter the 'North Temple', both with entrances facing south east, as is often the case on the Maltese islands. Surrounding the temples is a retaining wall, built mainly of very large megaliths. The space between the temple apses and the retaining wall is filled with rubble. Parts of the remaining walls reach a height of several metres: the highest, about 7m. In front of the temples is a more or less semi-circular platform, later in date than either temple, in fact, built in the Tarxien phase (c.3000-2500 BC).

A plan of the temples is given below (Fig. 4.1). An aerial view is shown in Fig. 2.11.

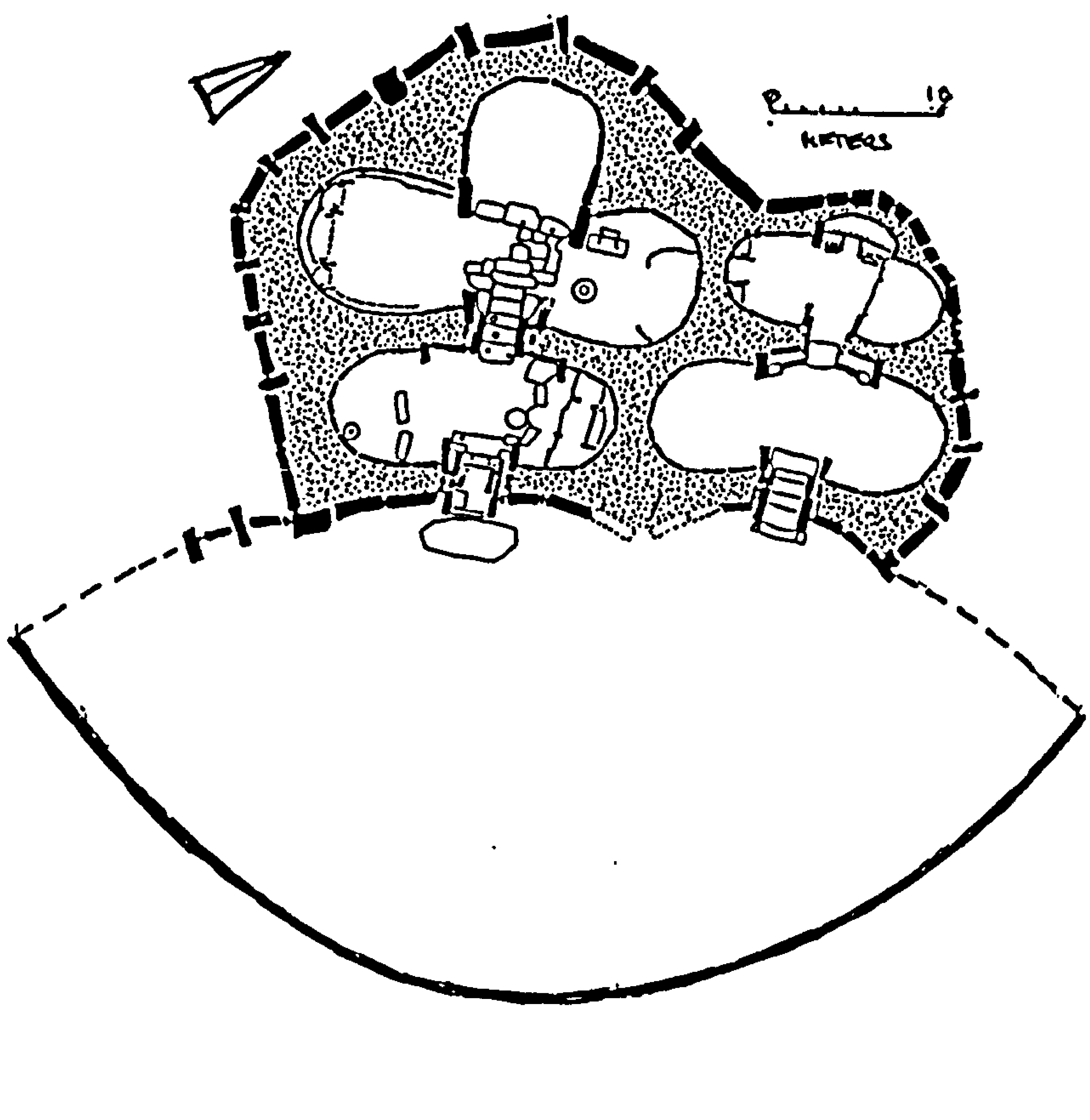


Fig. 4.1 Ggantija Temples, After Trump 1990 with Platform added by the author.

Both temples are built primarily of the hard Coralline limestone of the plateau on which they sit, as is the retaining wall of the platform. Some architectural features, such as door jambs and lintels, are of Globigerina limestone, which must have been brought from some distance.

Geomorphologically, the Xaghra plateau, on which Ggantija sits, is an irregular shape, sloping down on all sides, sometimes steeply, to lower levels of blue clay, which in turn, is surrounded by upper Globigerina limestone, the nearest to Ggantija being about 800m away. Further details of the geology and topography follow, when the sources of stone are being considered..

The above serves as a brief description of the Ggantija temples and their surroundings. What now follows, is a detailed assessment of the existing remains and their conjectural, original form. This assessment is preceded by copies of Evans (1971) plan and sections for reference. (Figs. 4.2 and 4.3)

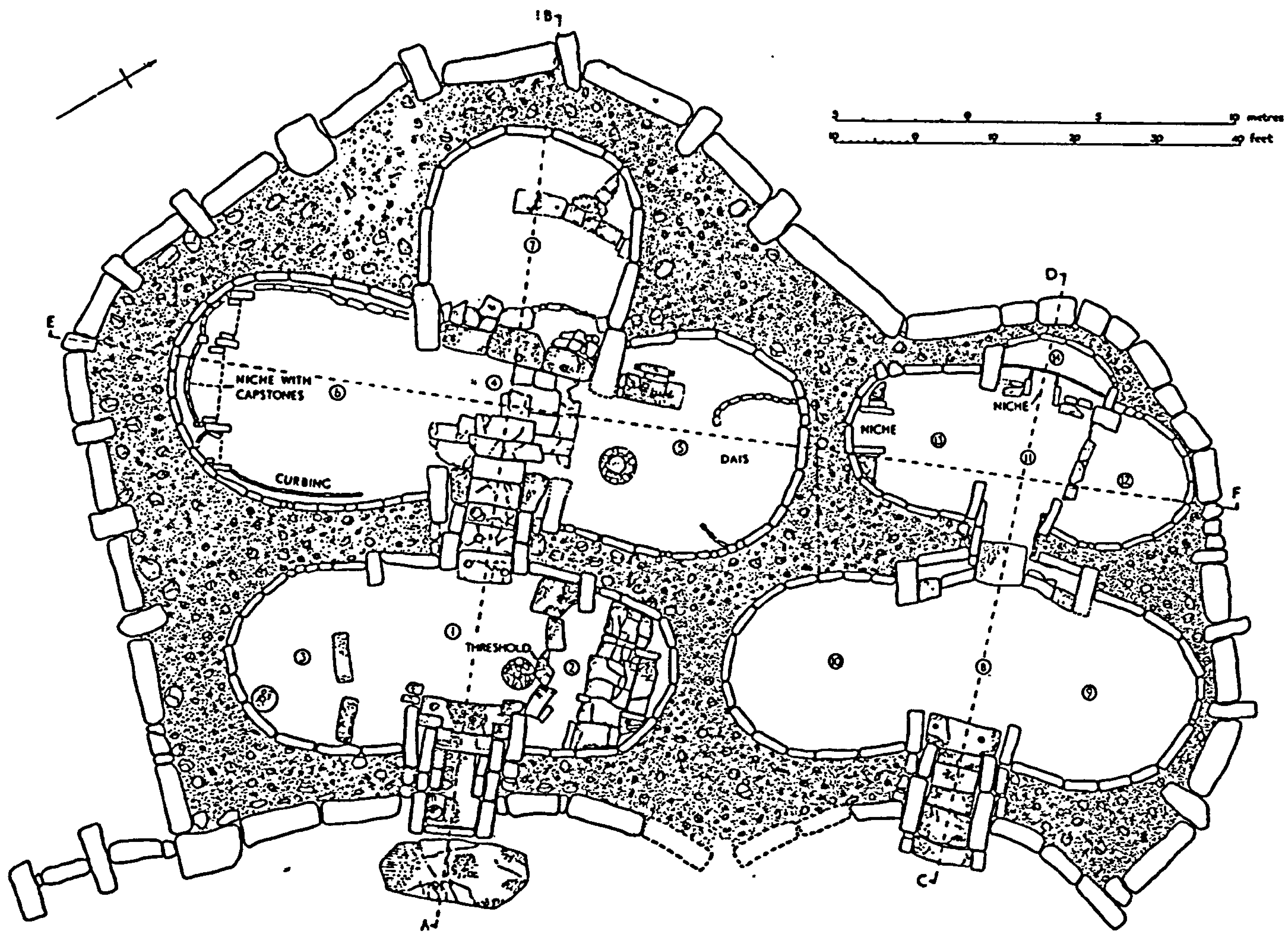


Fig. 4.2 Ggantija Temple Plan

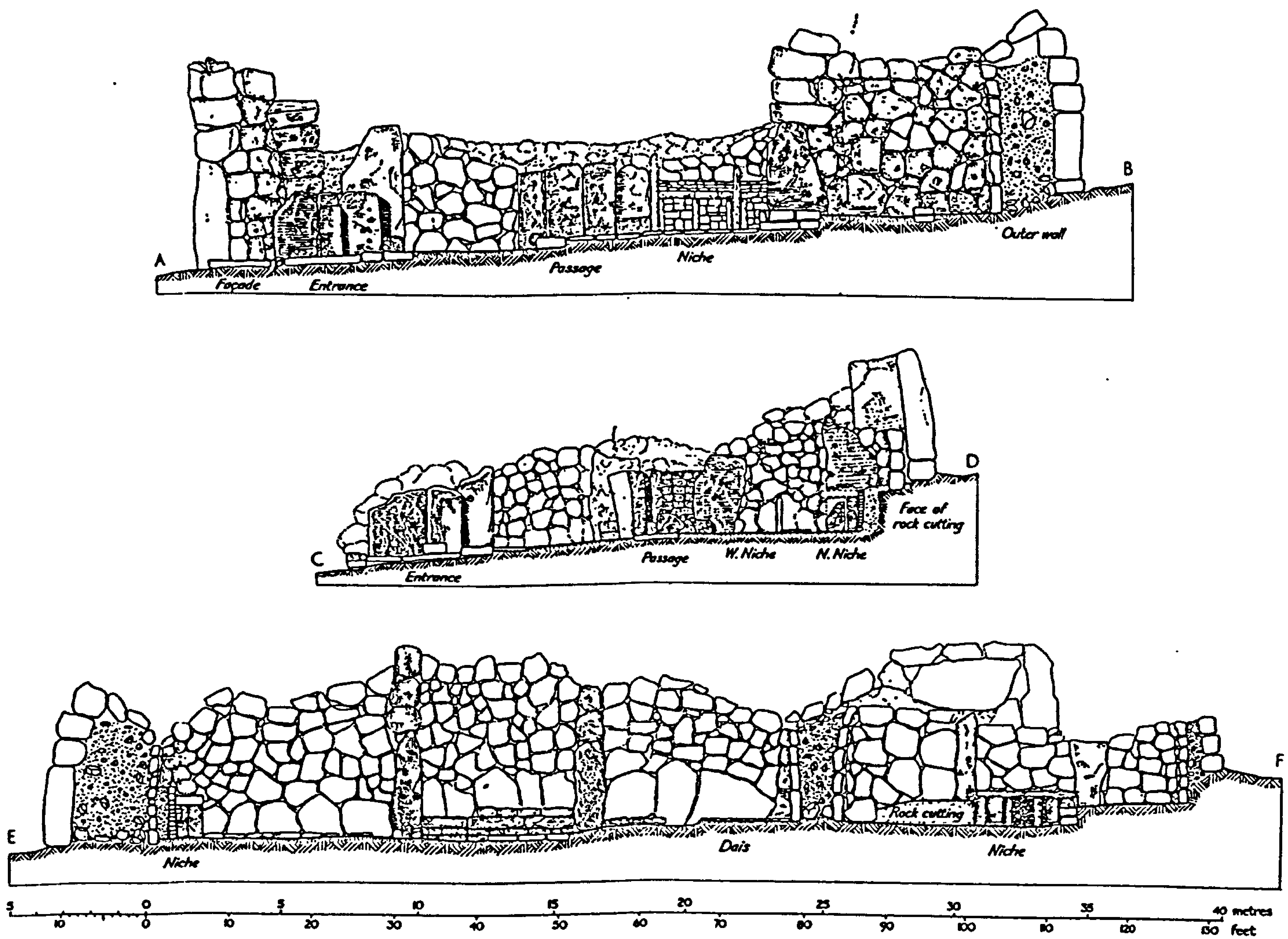


Fig. 4.3 Ggantija Temple Sections

Fig. 4.4 Entrance to Ggantija South Temple.

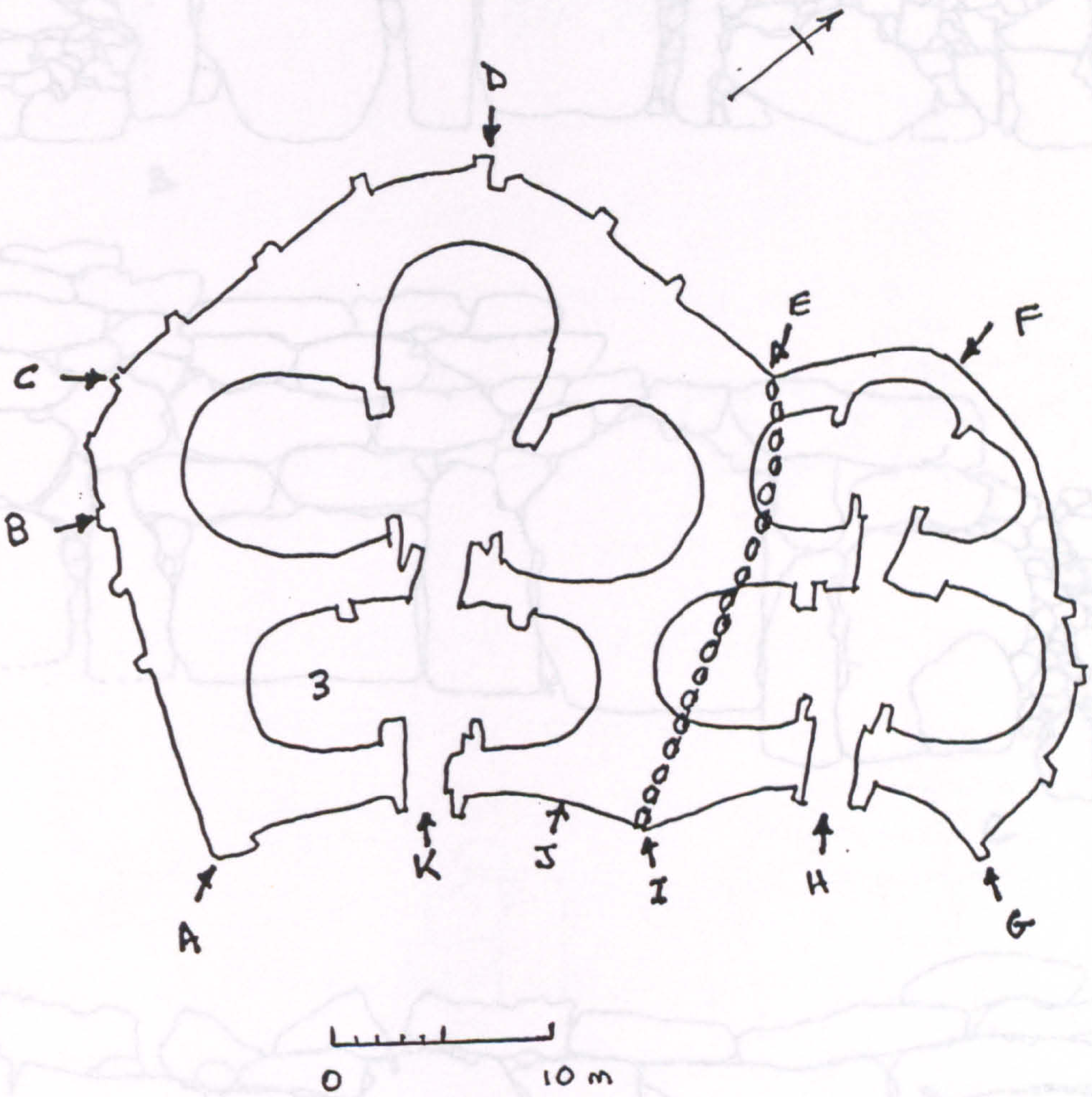
Fig. 4.5 Rear of Ggantija South Temple Perimeter Wall.

Fig. 4.6 View from rear of Ggantija South Temple.

Fig. 4.7 ?Altars in left rear apse Ggantija South Temple.

4.3 THE TEMPLES IN DETAIL : PERIMETER WALL : PHASING

Below is an orientation plan for this and subsequent sections:

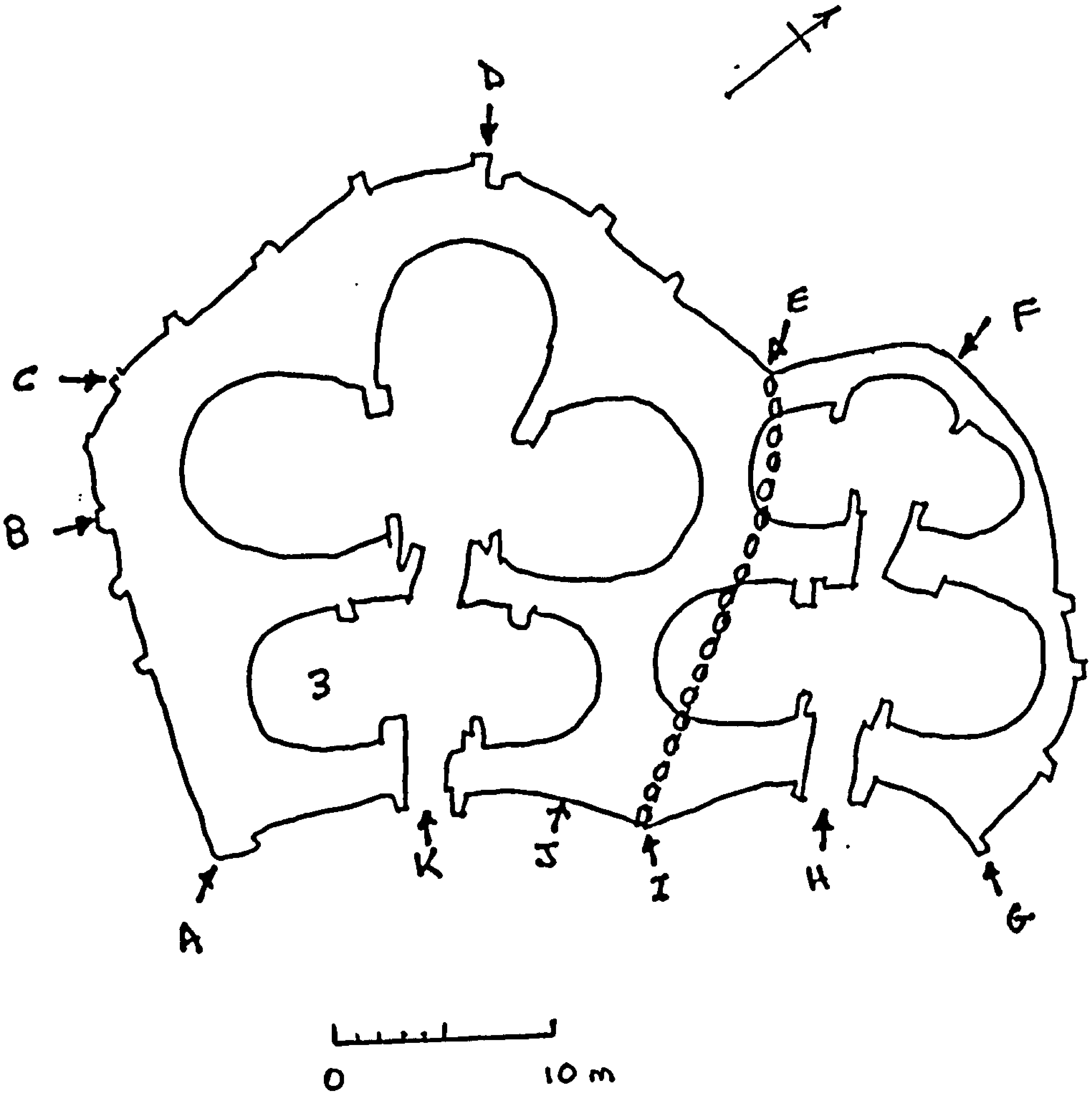


0000 Conjectural line of original South Temple perimeter.

Fig. 4.8 Ggantija Temple orientation plan.

The drawings that follow are of the whole circuit of the outer walls, starting in the south corner of the South Temple, marked A on the orientation plan, and proceeding in a clockwise direction. The drawings derive from a series of photographs taken by the author and scaled: therefore the scale given is approximate. All walls, as indicated on Evans' plan, are of single stone thickness. The original drawings were three times the scale of those presented here.

Below is an orientation plan for this and subsequent sections:



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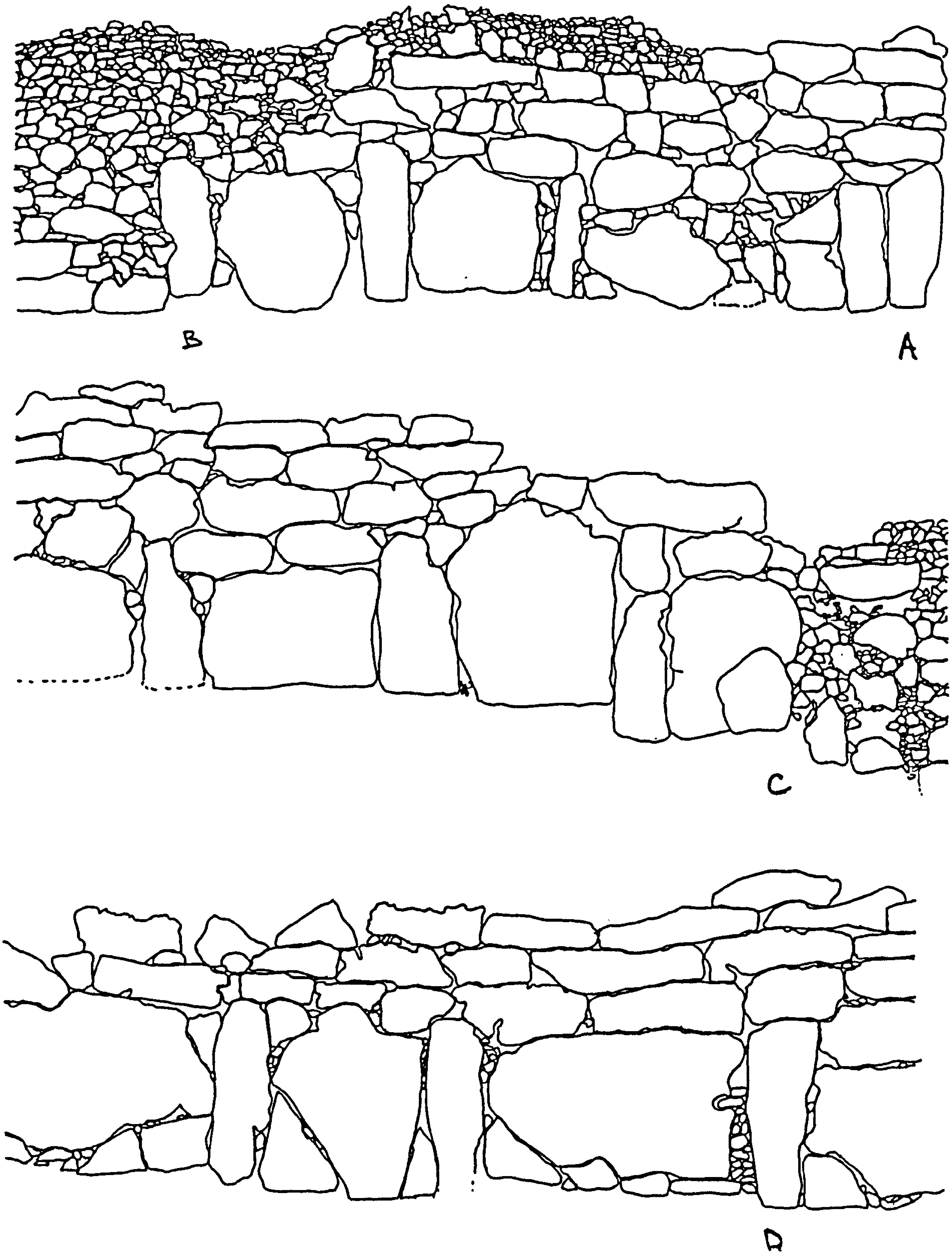
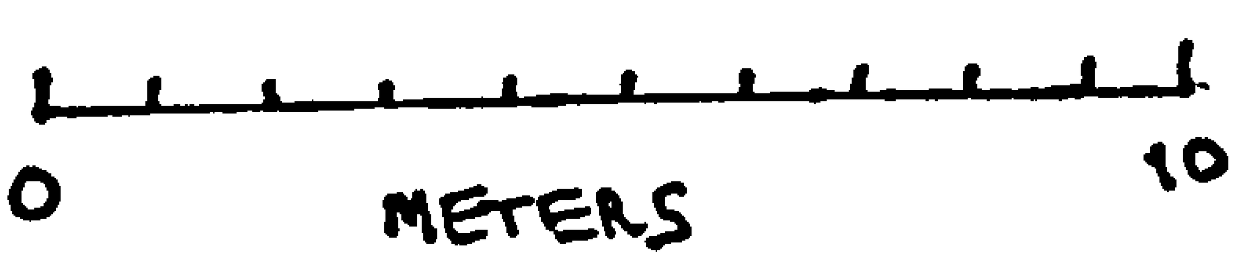




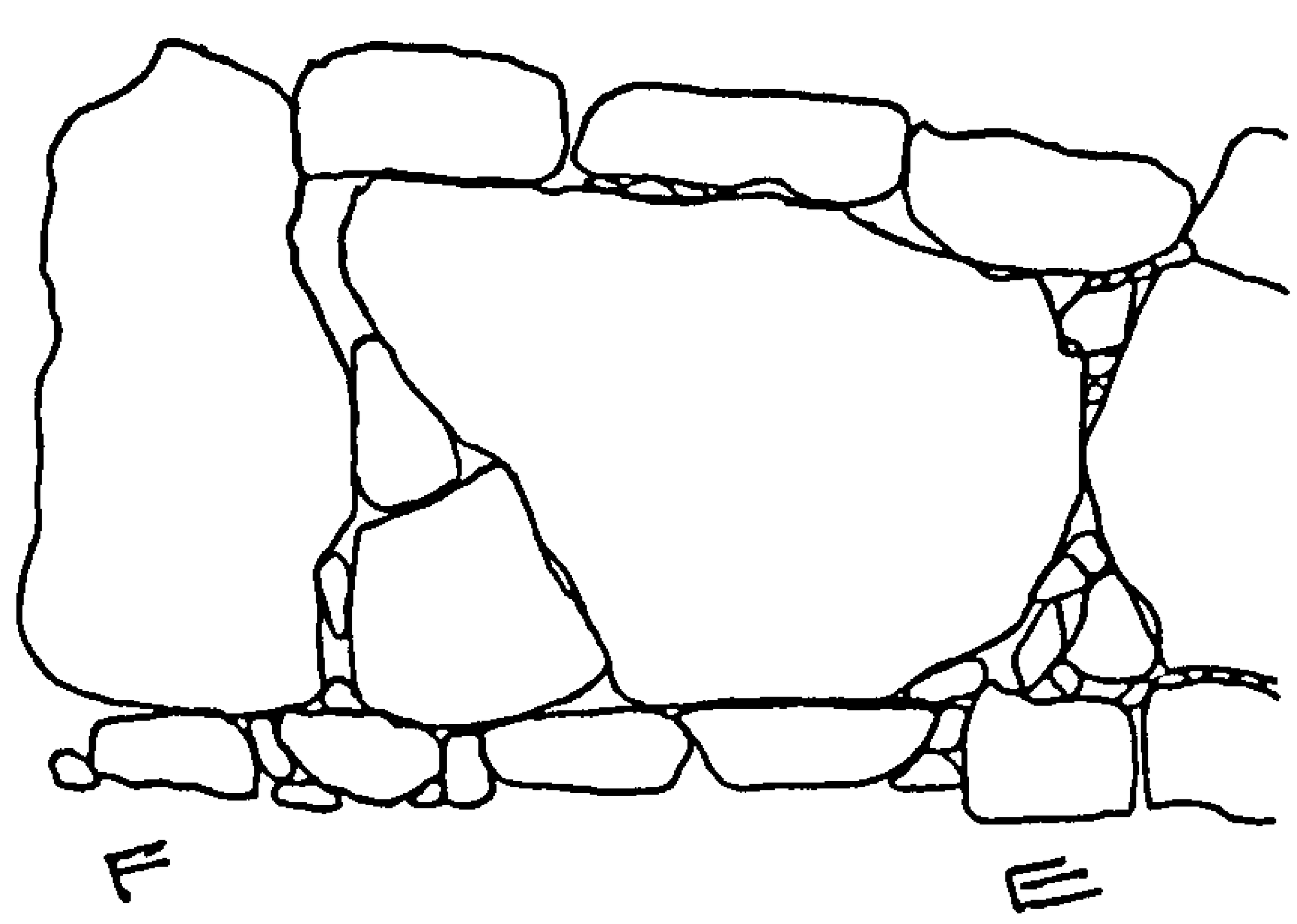


Fig. 4.9 Exterior elevation Ggantija

"Lapping" clockwise. ←

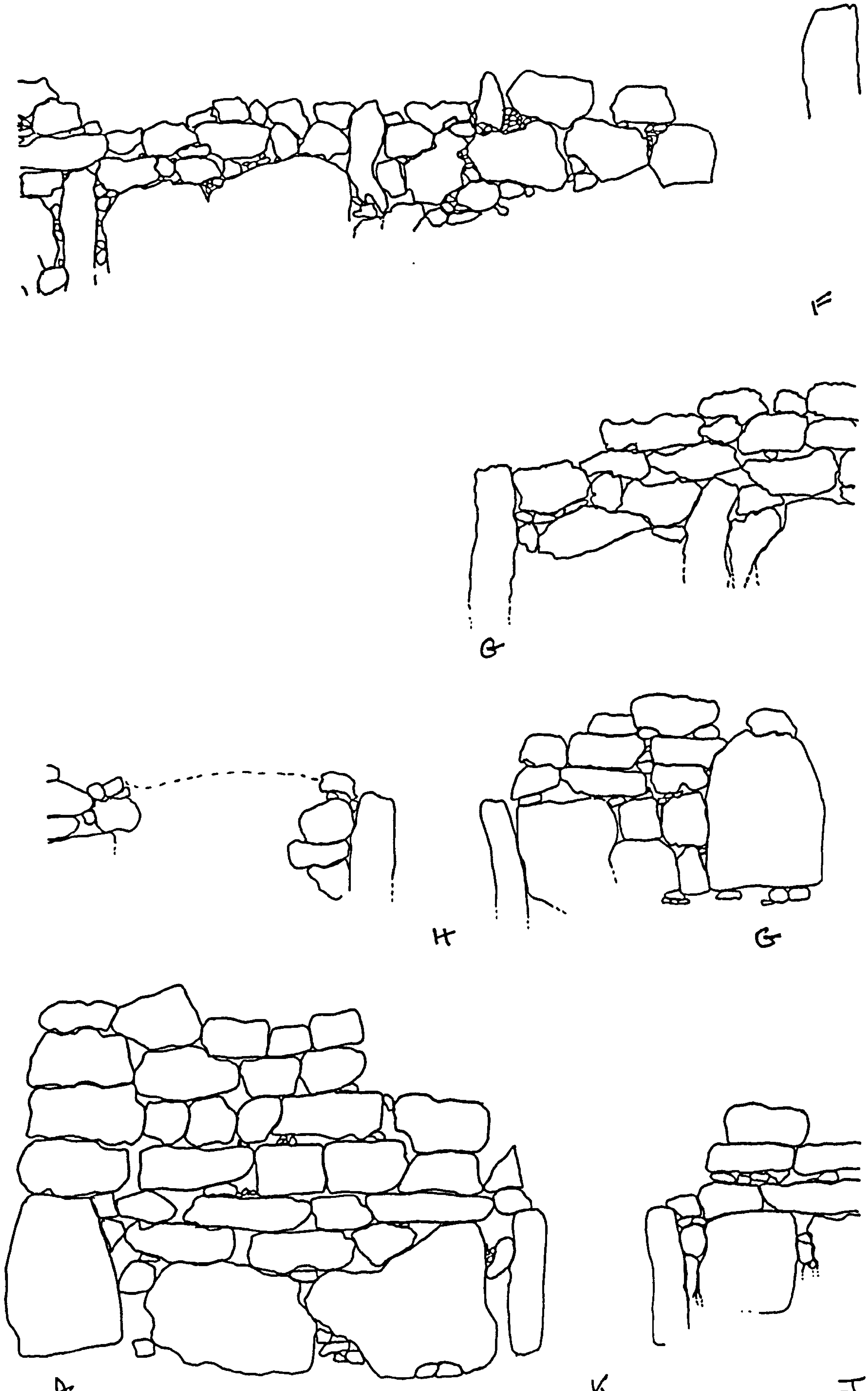


Fig. 4.9 Continued

The first observation one makes from these drawings, is that a plan of the base of the perimeter wall, such as Evans' (1971) gives an undue impression of unbroken monumentality. In fact, there are three sections where this is not the case, that is sections B to C, F to G, and H to J.

It is worth considering at this point, the question of phasing, as set out by Evans (1971 : 179-82). There are good grounds for concluding that the North Temple was built after the south one. Apart from the rubbly nature of section B to C, the whole wall from A to E shows fine megalithic construction, with the base stones laid on end, alternately, radially and tangentially, as Evans' plan and the author's elevations, show.

At E, there is a concave angle and the wall, so to speak, starts again. First, there are some good sized megaliths, culminating in a fine one at F. Thereafter, all the way from F to G, the wall is of generally smaller stones, low and ruinous. A good explanation is that the South Temple, when built, had a perimeter wall continuing from E to I. When the North Temple was built, this was dismantled and some of the megaliths were incorporated in E to F. The conjectural, original wall of the South Temple is shown E to I. This may be confirmed by the otherwise anomalous existence in the wall of the left hand first apse, North Temple, of the edge of a vertical block, one of the outer wall slabs of the original South Temple allowed to remain when the North Temple was built (Trump 1990 b : 159).

This conclusion on phasing is given further credence by the fact that the masonry of the apses of the North Temple is of a less high standard than that of the South Temple's apses. Thus it may be assumed that the north and South Temples were built in two distinct phases.

A further aspect of phasing concerns the South Temple. It will be observed from the plan that the three inner apses of this, are larger than the outer two. Evans (1971 : 180) is worth quoting in full on this point: "It would therefore be reasonable to suggest, though it is impossible to prove, that the South Temple was originally built as a huge trefoil, [a primitive trait in the development of temple plans] to which an extra pair of apses was subsequently added, probably because a new development of cult demanded it."

Evans' suggestion is perhaps advanced by the discontinuity in the perimeter wall section B to C, already mentioned. On the other hand, it may be that it was rebuilt at the time of the North Temple construction because of previous collapse. It does not seem modern as it shows on the earliest drawings, for instance, those of Brocktorff early in the nineteenth century. However, in other respects, the homogeneity of both internal construction and most of the external, suggests to the author that the building of the front two apses and the retaining wall for all five, were part of the same building programme. That is, that the idea of a five apse temple, rather than a three apse temple, if not at first planned, occurred during the building of the first three apses. It has been assumed in what follows, that the South Temple was built in one continuous phase.

A number of stones was accurately measured. Based on these and scaling off the stones from the drawings, the following data are derived from the section of wall from K to D, on the plan. This comprises the southern half of the South Temple. (The rubble section B to C has been measured as it now is.) The weights given were obtained by multiplying the relevant volumes in cubic metres by 2.2 (the specific gravity of Coralline limestone) to arrive at weights: (see below)

	Number of Stones	Maximum Weight tonnes	Average Weight tonnes	Total Weight tonnes
Stones over 2 tonnes	30	20.9	8.5	255.4
Stones 1-2 tonnes	37	2.0	1.4	51.0
Stones 0.5-1 tonne	52	1.0	0.5	25.9
Stones under 0.5 tonnes incl. Rubble	-	0.5	-	21.2

For the original South Temple, figures may be doubled.

The North Temple outer walls are in such a state of disrepair, that an accurate estimate is difficult. The total original length of the South Temple wall was 98m. (A-B-C-D-E-I-J-K-A on the plan). 20m of this were reused in the North Temple (E to I). The North Temple wall was 48m (E-F-G-H-I) of which 20m may be assumed to come from the South Temple, leaving 28m of new stone procurement.

Although the North Temple is of a lower standard than the South Temple, I have assumed the same masonry, per meter run, was required, certainly in overall dimensions, even if not in block size.

This gives the following figures:

Newly procured stone North Temple:

	Number of Stones	Maximum Weight tonnes	Average Weight tonnes	Total Weight tonnes
Stones over 2 tonnes	17	20.9	8.5	143.0
Stones 1-2 tonnes	21	2.0	1.4	28.6
Stones 0.5-1 tonne	29	1.0	0.5	14.5
Stones under 0.5 tonnes incl. rubble	-	0.5	-	11.9

Reused South Temple masonry in North Temple:

Stones over 2 tonnes	12	20.9	8.5	102.2
Stones 1-2 tonnes	15	2.0	1.4	20.4
Stones 0.5-1 tonne	21	1.0	0.5	10.4
Stones under 0.5 tonnes incl. Rubble	-	0.5	-	8.5

All these figures are based on the existing height of the South Temple wall K to D and need to be multiplied by a factor, depending on an assessment of the heights of the original walls, a matter considered later.

4.4 RUBBLE AND EARTH INFILL

A calculation has been made of the amount of rubble and earth infill involved in filling the gaps between the outer perimeter wall and the inner apse walls of the southern half of the South Temple, using Evans' (1971) plan and sections (i.e. bounded by K-A-B-C-D-K on the orientation plan). The figures are:

Plan area	146sq m
Average height*	5m
Volume	730cu m, say 1460 tonnes

* see discussion on height of the original temple, later in this chapter.

These figures should be doubled, to give the infill for the whole South Temple, assumed to be bounded by the line E to I, on the plan.

Some of this would have been reused when the North Temple was built. The figures for the balance of the North Temple are:

Total area	16.1sq m
Reused are	6.9sq m
Newly procured area thus	9.2sq m
Average height*	5m
* see above	
Volume	46cu m, say 92 tonnes

4.5 <u>APSES : Stone Sizes, Quantities etc.</u>

Apse 3 is marked on the orientation plan Fig. 4.8.

Fig. 4.10 is a photograph of this apse.

Fig. 4.11 is a drawing of the apse wall, taken from a series of photographs and is therefore only approximately to scale. Stones number 1-6 were measured accurately and their dimensions are given below. These were then used to provide data on the whole apse, as also detailed below:

Fig. 4.10 Ggantija apse 3 from north north west

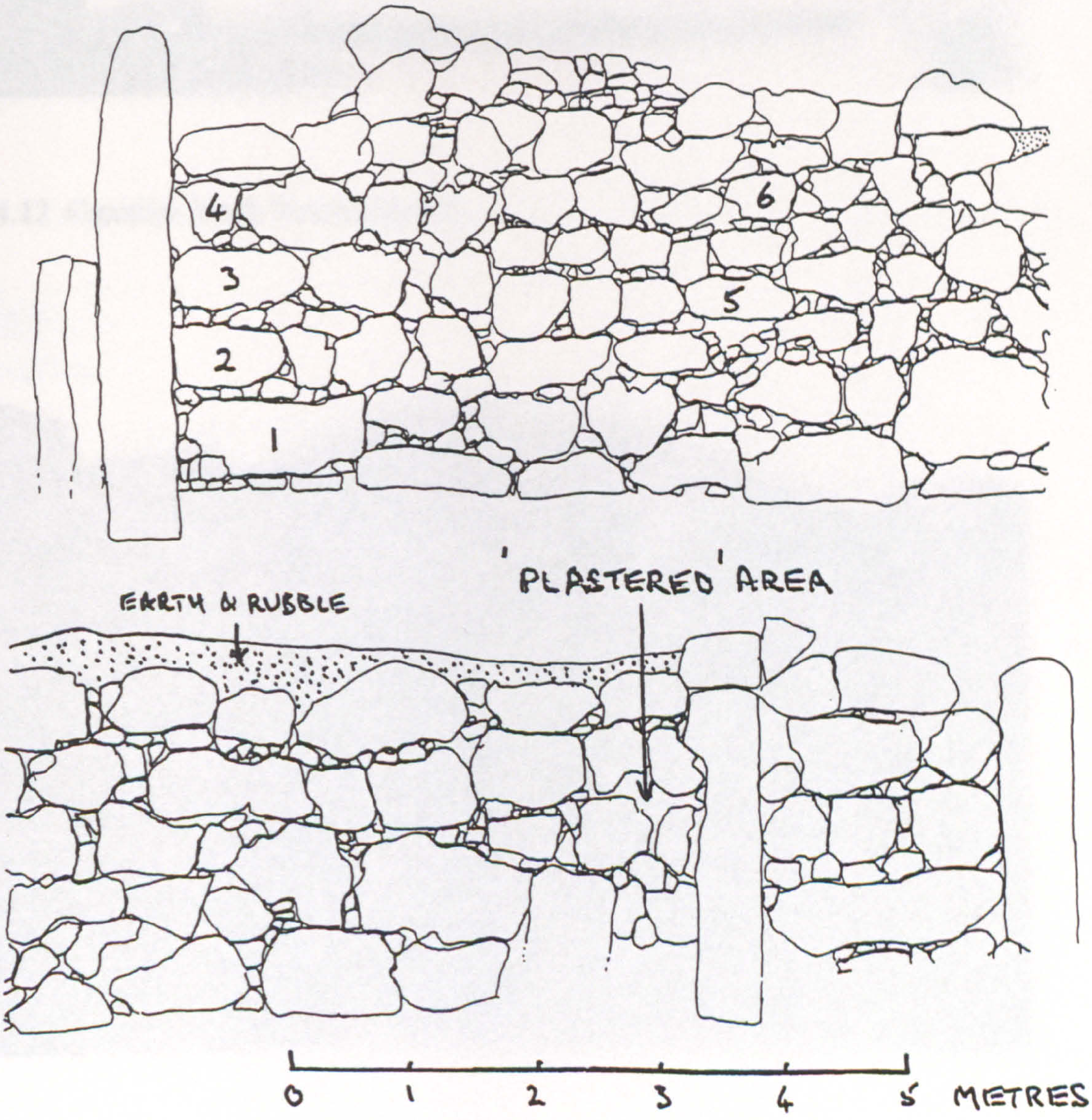


Fig. 4.11 Interior apse 3. "Lapping" clockwise →

Fig. 4.12 Ggantija South Temple apse 3.

Fig. 4.13 Detail of Ggantija South Temple apse 3.

Measured stones:

Stone No.	Width	Height Cms	Depth	Square Metres*	Cubic Metres*	Weight at 2.1 sg
1	180	50	50	0.72	0.36	756kg
2	110	60	50	0.53	0.26	546kg
3	130	60	50	0.62	0.31	651kg
4	60	60	80	0.29	0.23	483kg
5	110	45	50	0.40	0.20	420kg
6	80	60	50	0.38	0.20	420kg
Average			55	0.49	0.23	483kg

* Reduced by 20% to allow for lack of rectilinearity.

The total number of large stones is 91.

The total area of the large stones is 91 x 0.49 = 44.6sq m.

The total apse area inner surface = 52.5sq m.

The area of small stones is (52.5–44.6) x 0.5 = 4.0sq m with a depth of say 20cms.

The large stones range in weight from 756kg down to 420kg, with an average of 483kg.

Total weight of the large stones = 91 x 483kg = 44 tonnes.

The small stones (liftable by one man), weight, in total, 4 x 0.2 x 2.1 = 1.68 tonnes.

The South Temple has five apses. Three of the size measured and of the other two, one is 40% bigger and the other 20% smaller. So for the whole temple, we need to multiply the above figures by 1 + 1 + 1 + 1.4 + 0.8 = 5.2.

The North Temple has four apses and a nearly flat back "sanctuary". In relation to the South Temple apse 3, which was measured, these represent 100%, 90%, 70%, 50% and 30% of that apse, respectively. So the total lineage is 1 + 0.9 + 0.7 + 0.5 + 0.3 = 3.6 x measured apse. (The North Temple apses are more crudely built, but the assessment remains reasonable.)

Thus, in summary:

Stones	South Temple	North Temple
Small stones	1.68 x 5.2 = 8.7	1.68 x 3.6 = 6.0
Large stones	44 x 5.2 = 228.8	44 x 3.6 = 158.4

All these figures are based on apse 3 of the South Temple, which has an average remaining height of 3.0m. For reconstruction purposes, they need to be multiplied by a factor depending on an assessment of their original height.

4.6 THE QUESTION OF ROOFING

When considering the problem of the original height of the walls, the question of whether the temples were roofed and if so how, is a crucial one, as well as being of intrinsic interest.

This problem has been reviewed at some length, because there is a major difference of opinion between what might be described as the Italian school and the British. The dispute is between whether the temples were roofed by stone beams laid over inward battering walls of the apses, or by timber beams overlaid with brush and perhaps turves. Unfortunately, the issue became a nationalistic one, encapsulated by the following quotation from Tampone et al (1987 : 11), in paraphrased translation:

"The English School is unaware of the fundamental contribution in architectural and structural interpretation made by Carlo Ceschi, the only complete, documented and reliable study of its kind, mentioned only in the most extensive bibliographies. This school is still dependent upon simplistic versions, such as wooden beams and branches held together with earth (eg. Trump), which take as evidence, traces of fire found inside some rooms, especially in the temple of Tarxien."

This echoes an earlier comment by Paribeni in his preface to Ceschi's publication in 1939 (p.11) when he said: "We must be happy that after so many researches, undertaken by scholars of every country, this result [that of monumental stone roofing] has been seen and achieved by an Italian scholar."

The author's review covers the literature, and considers the possibilities of:

- no roofs
- roofs of wood and other material
- roofs of stone slabs

The author's conclusions are that:

- the temples were roofed
- that the later, Tarxien phase temples, may have been roofed with stone slabs, though this is unlikely
- that Ggantija period temples, and Ggantija in particular, were roofed with timber and other plants/other material.

There follows a review of scholarly opinion.

Ashby and his colleagues (1913 : 6), say of Ggantija and Mnajdra: "The apses were certainly roofed, and it is indeed possible that the whole of the oval area was covered." But they give no evidence for this assertion.

Of the south building at Kordin, they say, of one of the apses (G): "The roof was probably a beehive roof, like those of the nuraghi of Sardinia." (p.41); and of another (p. 47): "The wall between M and L is only a single block thick, and whether, and, if so, how M was roofed, is not altogether clear." (See plan : Fig. 4.14)

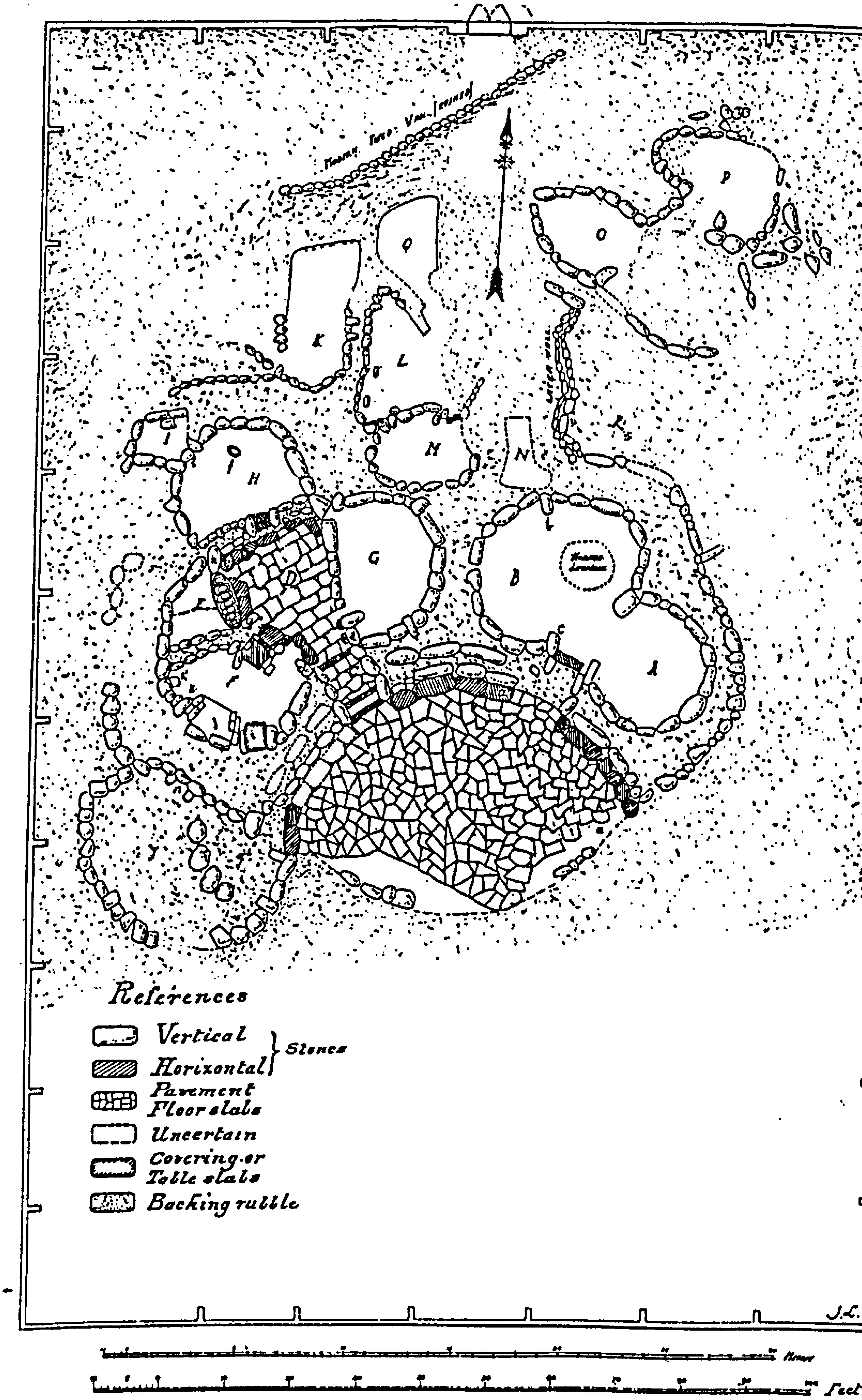


Fig. 4.14 Kordin temples : from Ashby and colleagues 1913 Plate V.

Zammit (1930) excavated Tarxien from 1915-1917, shortly after its accidental discovery in 1914 and reported on it in detail. He says (p. 31):

"Another extremely interesting feature was discovered in this apse. At the corner, where the beautiful niche is standing, a stone was found in place on the top of the first wall-slab, one of the first row of the ashlar masonry that in the shape of a dome, covered the apse. This stone is distinctly wedge-shaped with the upper surface inclined in the direction of the radius of the curve required to form an arch. This stone then, was evidently one of the springers of the arch. The architectural importance of this material, proof that the builders of the Stone Age temple knew how to lay the foundation of an arch, is obvious to all, and, although no complete cupolas built on this scientific principle have survived, the evidence of this unmistakable springer *in situ*, deserves the earnest attention of both archaeologists and architects. Hitherto, it had been observed only that the doming of the apses in the Maltese, megalithic buildings, was designed on the corbel system, in which each row of roofing stones, projects beyond the one next below it. Thus at Hagar Kim and Mnajdra, this certainly was the system adopted."

As we will see later, this suggestion of arches, as opposed to corbels, as a method of roofing, has been rejected by all subsequent scholars.

The other reference to roof made by Zammit, is as follows (*op. cit.* : 80)

"The domed apses and the covered passages were undoubtedly the first to collapse. Covering the floors with debris consisting of the broken slabs as well as of all the objects that were crushed under the stones. In many cases, however, it appeared that many of the objects were broken intentionally before the collapse of the building, for fragments of important vases were found in distant parts of the ruins."

The first serious work on the question of temple roofing, was done by Ceshi (1939), who was an Italian architect, asked by Ugolini, an Italian archaeologist, to consider the question. Ceschi compared Maltese temples with the nuraghi of Sardinia, the sesi of Pantelleria and the talayots of the Balearics, in relation to their (corbel) roofing, without of course realising in 1939, that the Maltese examples antedated the others by up to 2000 years. Ceschi draws attention to the little limestone model of a temple found at Mgarr (Fig. 4.15) In plan, this is elliptical with vertically placed block walls, a trilithon entrance and horizontal slab roofing at right angles to the long axis.

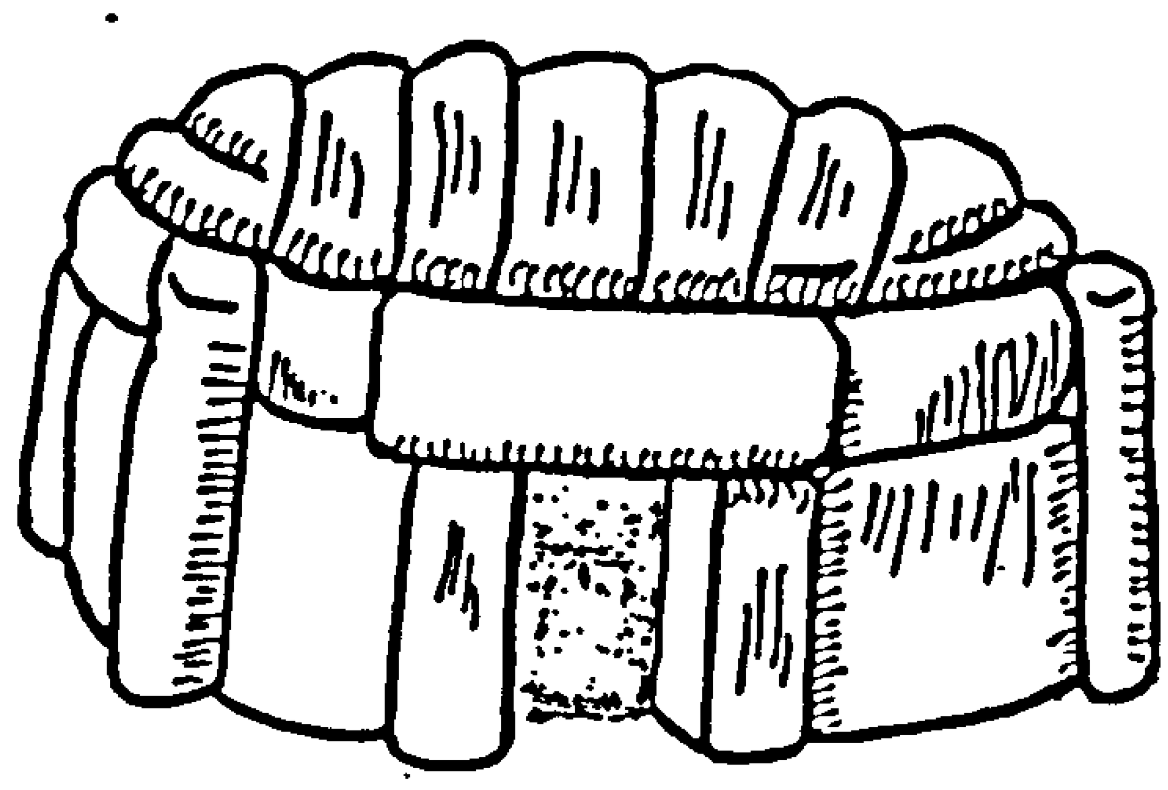


Fig. 4.15 Drawing of a model temple from Mgarr

Ceschi (*op. cit.* : 24) notes one important aspect of temple construction, namely the connection between the outer surrounding wall and the inner apse walls. The outer perimeter walls have, at their base, large orthostats laid alternately in line with the plane of the wall and at right angles to it. The apse walls are in effect "horizontal arches". Between the two is an infill of rubble and stone. This infill is retained by the robust construction of the outer wall and puts pressure on the horizontal arches of the apse walls, thus consolidating the whole. Whatever the roof, this construction created a very strong edifice and no doubt explains their remarkable preservation for 5000 years. See Fig. 4.16.

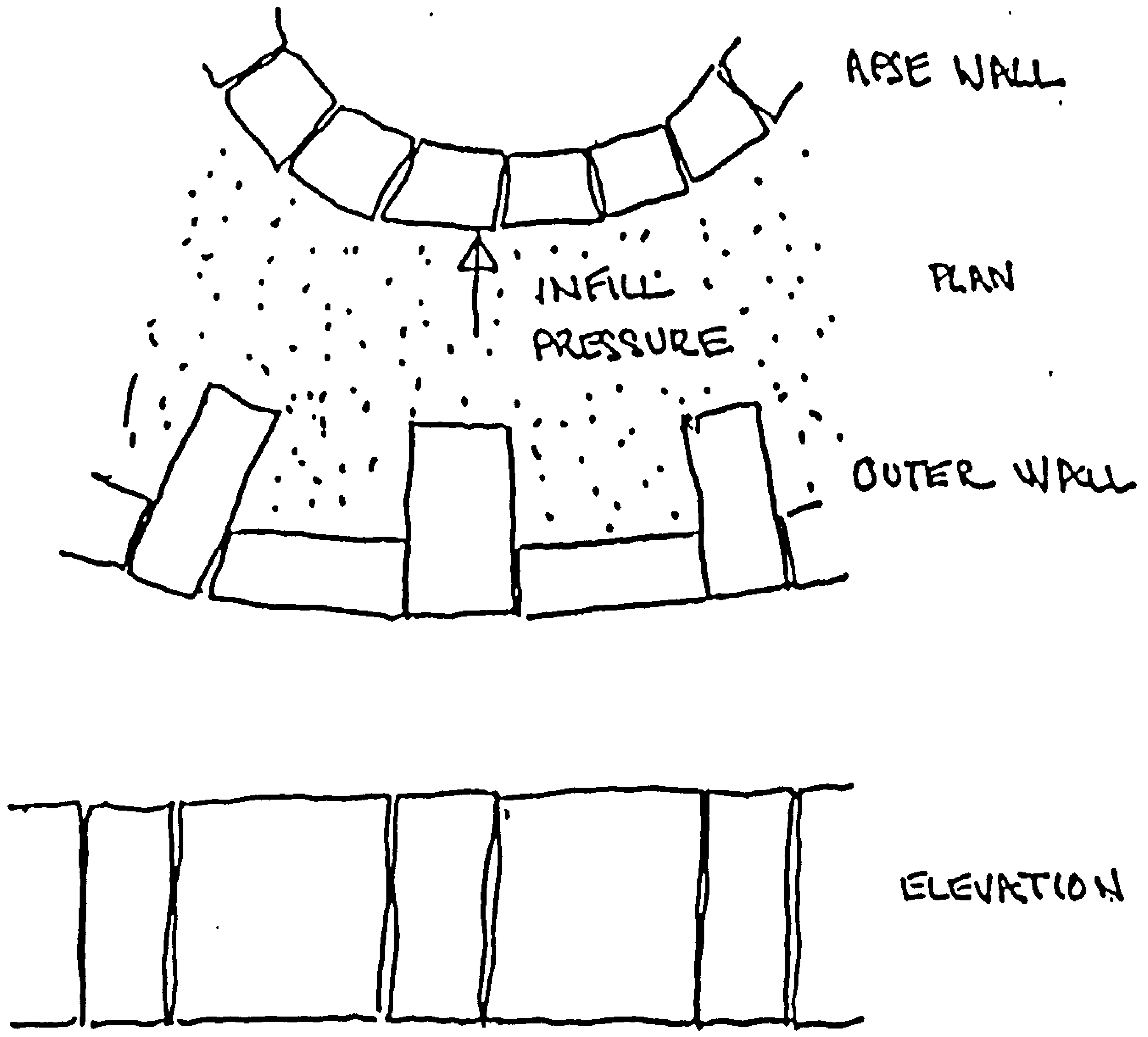
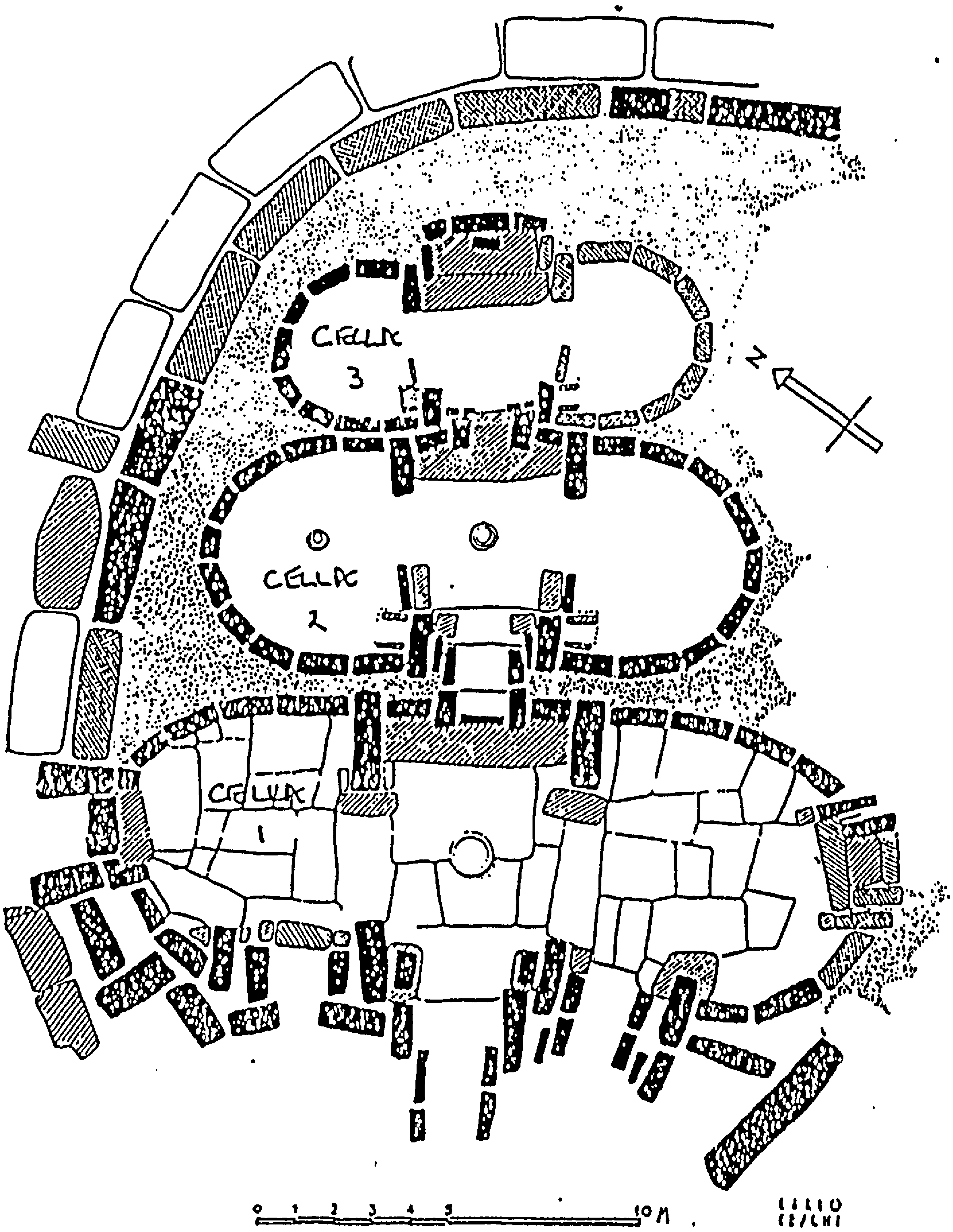


Fig. 4.16 Schematic plan and elevation of inner and outer walls and infill.

Ceschi considered the block that Zammit had taken to be an arch springer (see above) and concluded that it had been repositioned at a date subsequent to its initial placement. (A view also held by Evans (eg. 1959 : 119)

Ceschi says (*op. cit.* : 52) "With these data, it is possible to establish an approximate line of the governing curve of the false vault that reaches higher or lower heights, according to the greater or lesser size of the apses."

Fig. 4.17 shows Ceschi's plan reconstruction of temple III at Tarxien and Fig. 4.18 his reconstruction of (his) cellas 2 and 3, there.



Walls of existing vertical slabs
Walls of hypothetical vertical slabs
Existing horizontal Slabs
Hypothetical horizontal slabs

Fig. 4.17 Reconstruction of Temple III Tarxien.

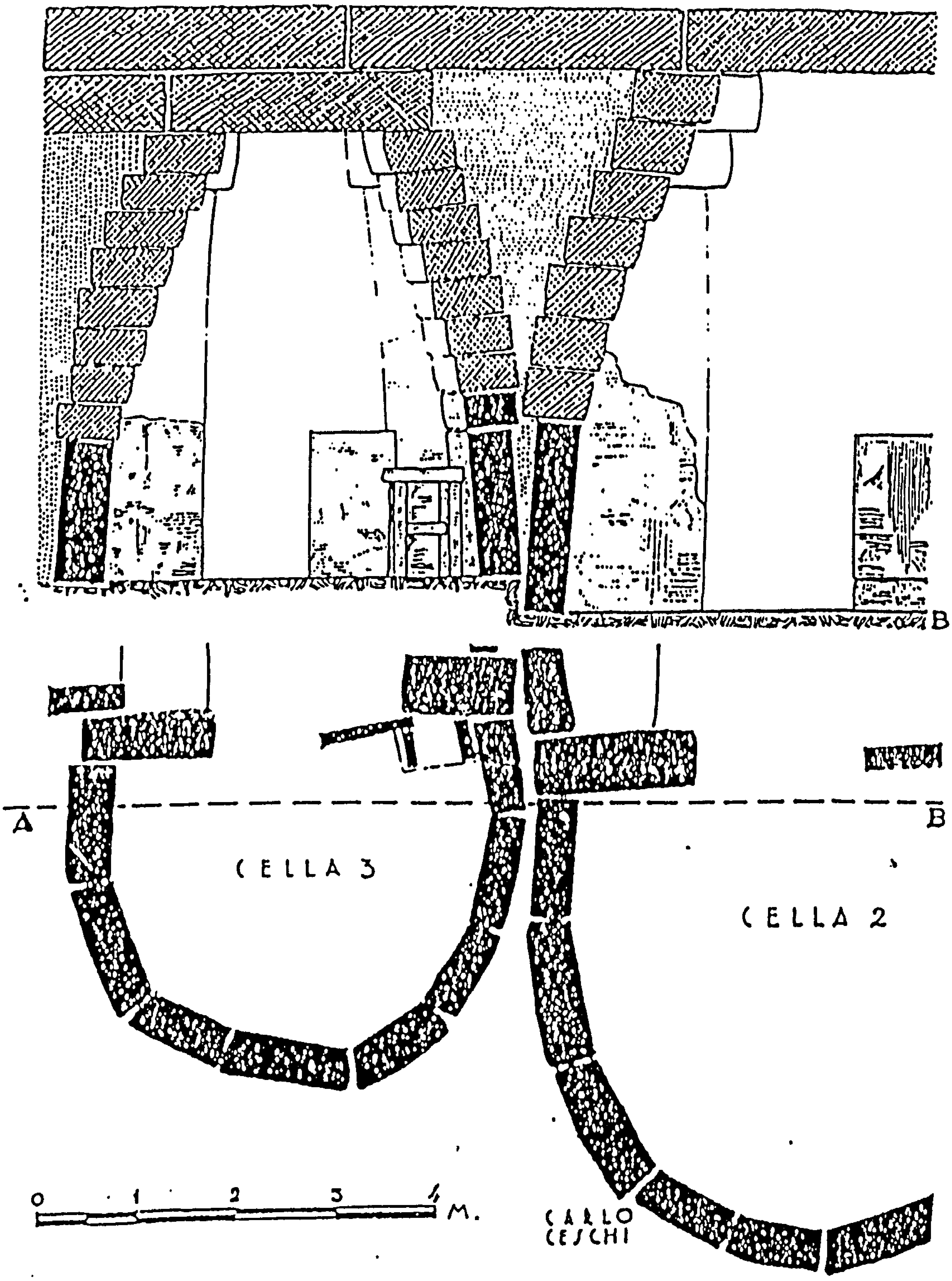


Fig. 4.18 Reconstruction of the roofing of Cellas 2 and 3 of temple III at Tarxien.

He goes on to say that the conceptualisation of the original temple roofing is aided by consideration of the underground hypogeum of Hal Saflieni. (p. 58-59, paraphrased translation): "Not that it is possible to create a constructive parallel between a series of spaces carved in the tuff [*sic* – actually Globigerina limestone] rock at considerable depth, and an organic temple from above ground, but who descends into the hypogeum after some days of contact with the remains of the temples, cannot but remain struck by a sense of familiarity that he discovers in the architectural masses of the walls of the dark caverns. ... a building in a cave, probably destined for the same use as the temples, would have resounded with the same artistic style. One should not, therefore, wonder too much at the finding underground, of forms common to the temples above ground".

Fig. 4.19 shows Ceschi's reconstruction of a room in the hypogeum.

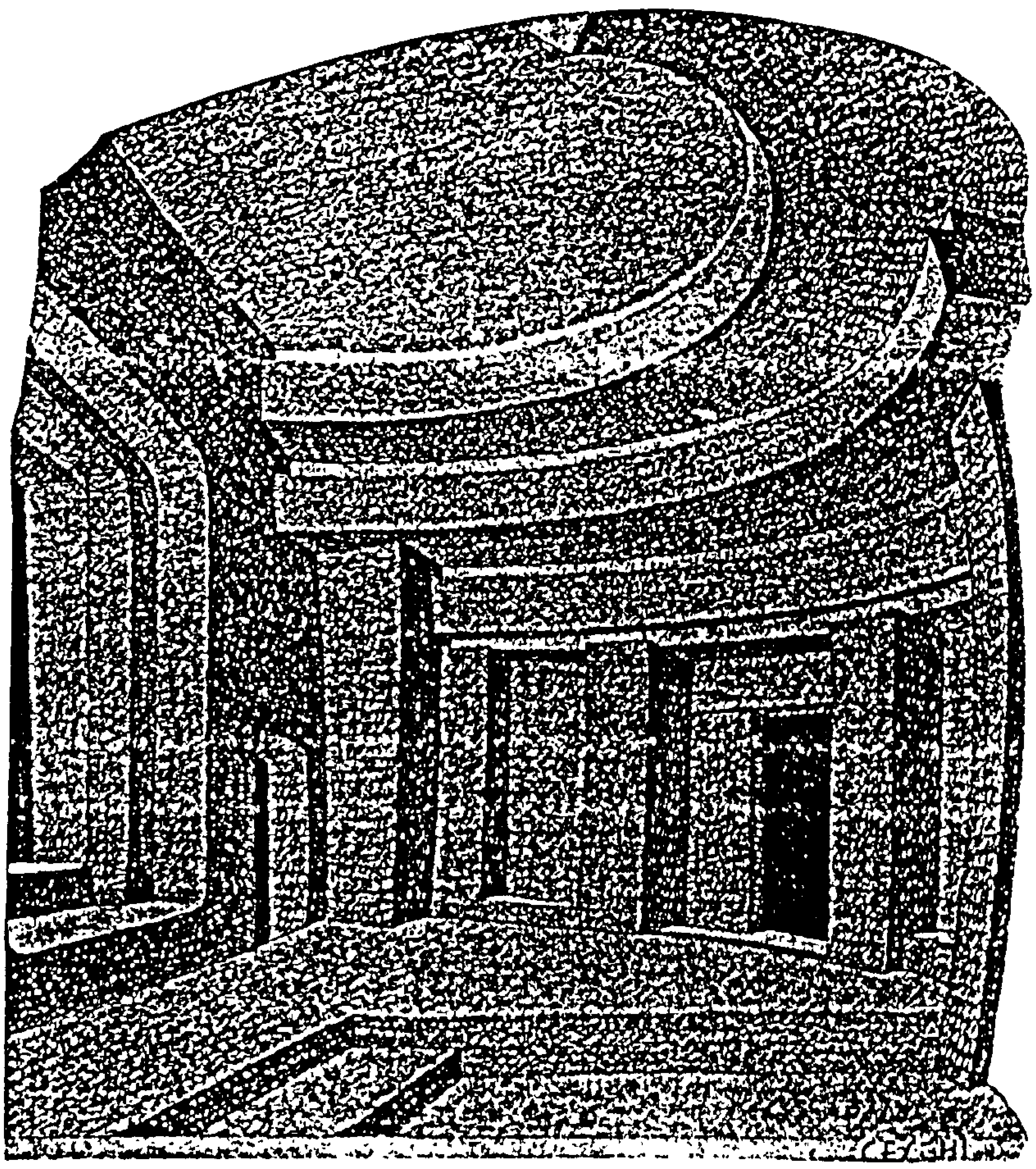


Fig. 4.19 Reconstruction of an almost fully preserved room at the Hal Saflieni hypogeum.

Then follows an interesting reconstruction of an apse at Ggantija. Ceschi's photograph is rather obscure, so the Author's has been substituted. Fig. 4.20, see also Fig. 4.10.

Fig. 4.20 View of the entrance to and part of the inside of the outer left apse of the South Temple, Ggantija.

Fig. 4.21 shows Ceschi's reconstruction of the entrance and part of the apse. The trilithon reconstruction is entirely plausible, but note the translation from the rough blocks of the apse walls in the photograph, to the dressed ashlar walls in the reconstruction. Ceschi's reconstruction is implausible: Coralline limestone is very hard to dress and, unlike Globigerina limestone, is very durable. This will later form a crucial part of the discussion of possible roofing methods.

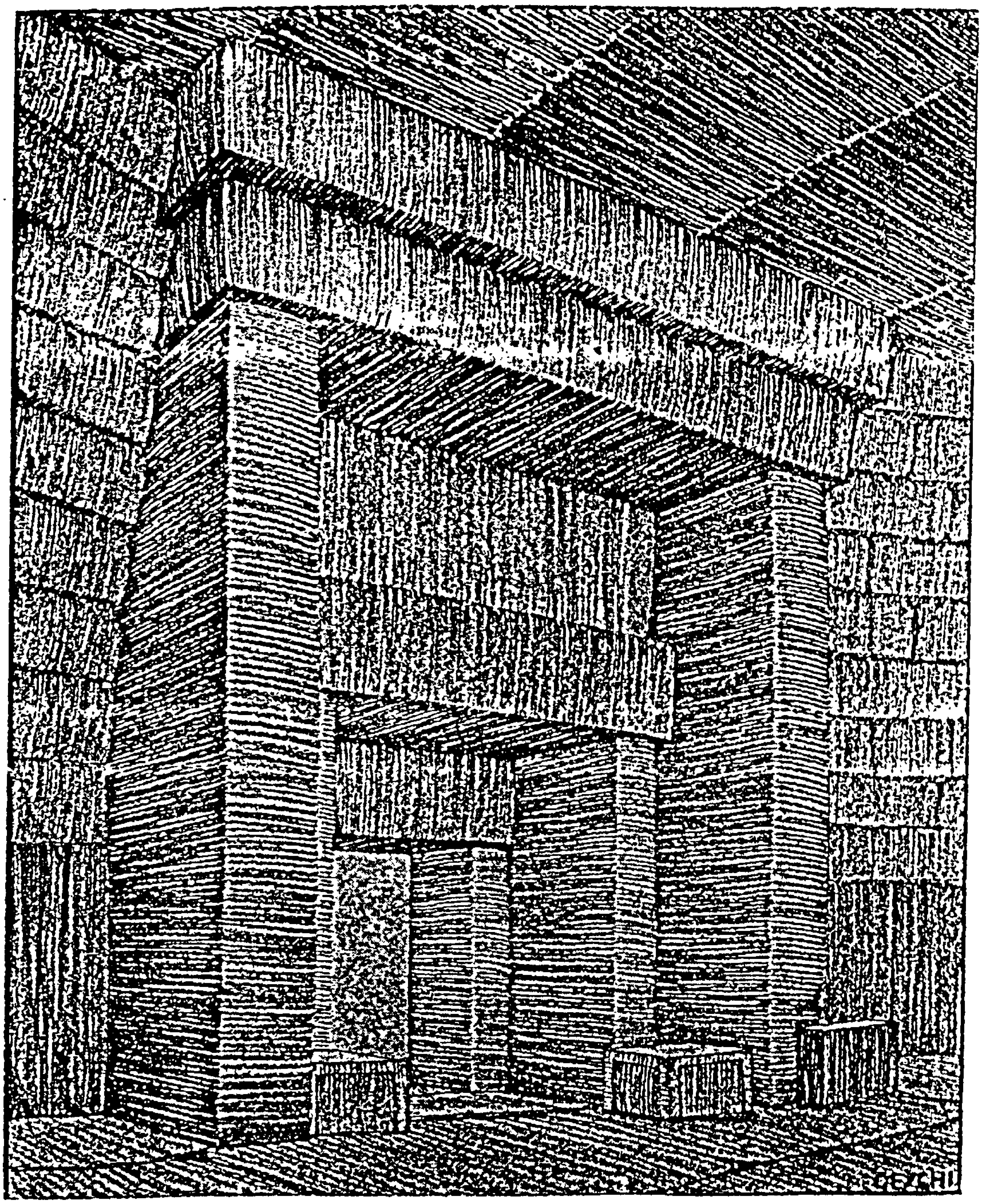


Fig. 4.21 Reconstruction of the entrance to the first pair of apses at Ggantija.

Ceschi concludes his work by giving reconstruction plans and elevations and interior reconstructed views of temples at Tarxien. An example is given in Figs. 4.22 and 4.23. Finally, in answer to the criticism that as he envisages the originals, there would have been no light, he says that would certainly have been so in the hypogeum at Hal Saflieni and this would have required artificial light; and further that if the temples had not been roofed, their furnishings, made of soft Globigerina limestone, would soon have eroded away. This seems to be a valid argument.

The next serious piece of work on temple roofing, was that done by Tampone, Vanucci and Cassar (1987), in relation to the Ggantija temple. They also refer to the Mgarr "model" (Fig. 4.15). They assert that the irregularity of Ggantija's apse walls is the result of the "depredations which these buildings have undergone in the course of several thousand years". (*op. cit.* : 8).

This would seem to be inaccurate for the following reasons:

- The Coralline limestone, of which the apse walls are built, is hard, durable (unlike Globigerina limestone) and not easily worked: hence the roughness of these surfaces.

- In the rear apse of the South Temple, the colour of the stones gives a clear indication of the height of the debris cleared in the 1820's "excavation", and at the same time, there is no difference between the surfaces of the blocks above and below this line.

Tampone, Vanucci, and Caspar (*op.cit.* 11) state, in paraphrased translation: "The theory of a stone roof ... is plausible from a strictly technical and constructional viewpoint. Structurally, the slabs we hypothesise can be thought of as rectangular beams on simple supports. Allowing that the beams were 5m long, [this is reasonable from the point of

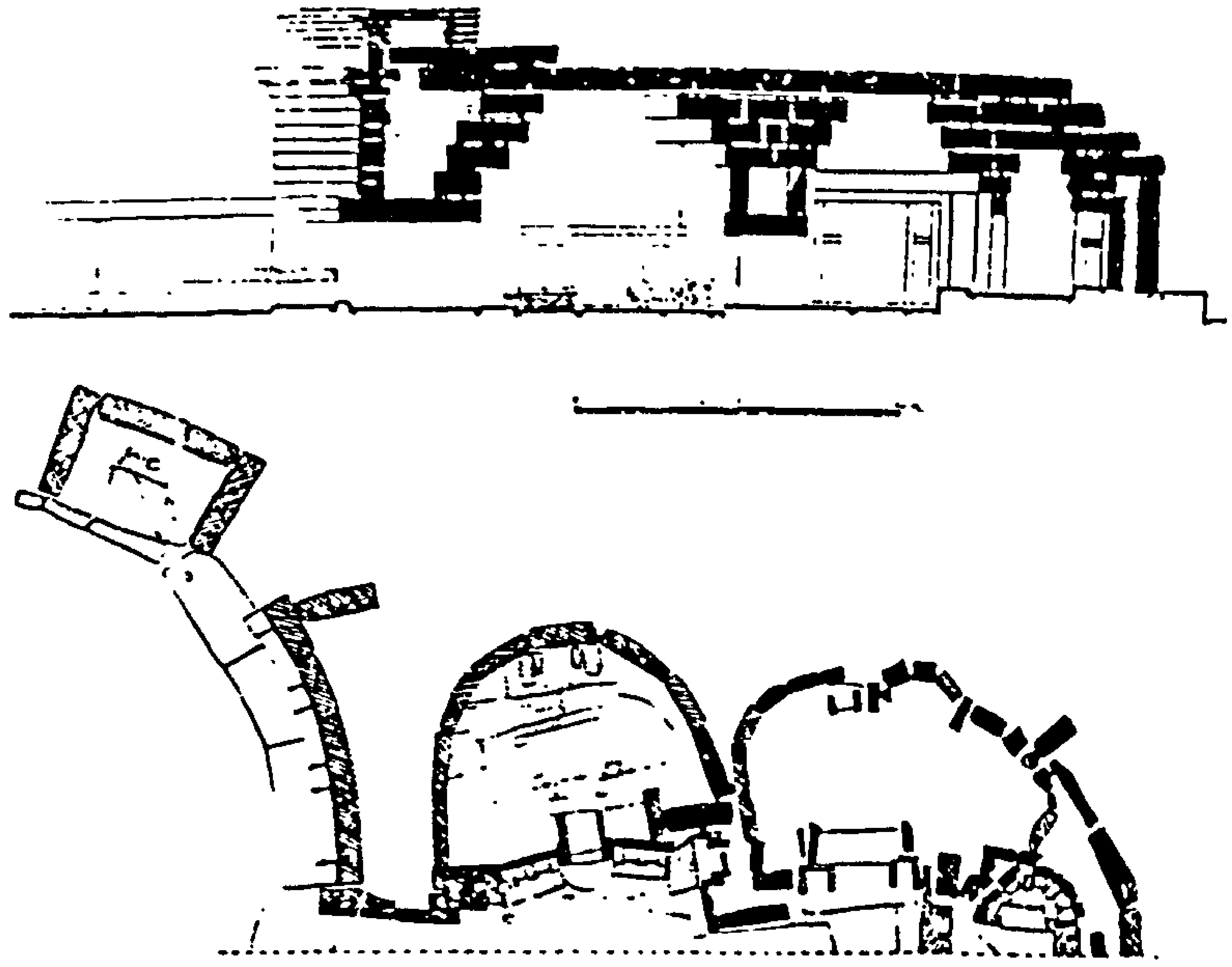


Fig. 4.22 Reconstruction section and plan Temple 1, Tarxien.

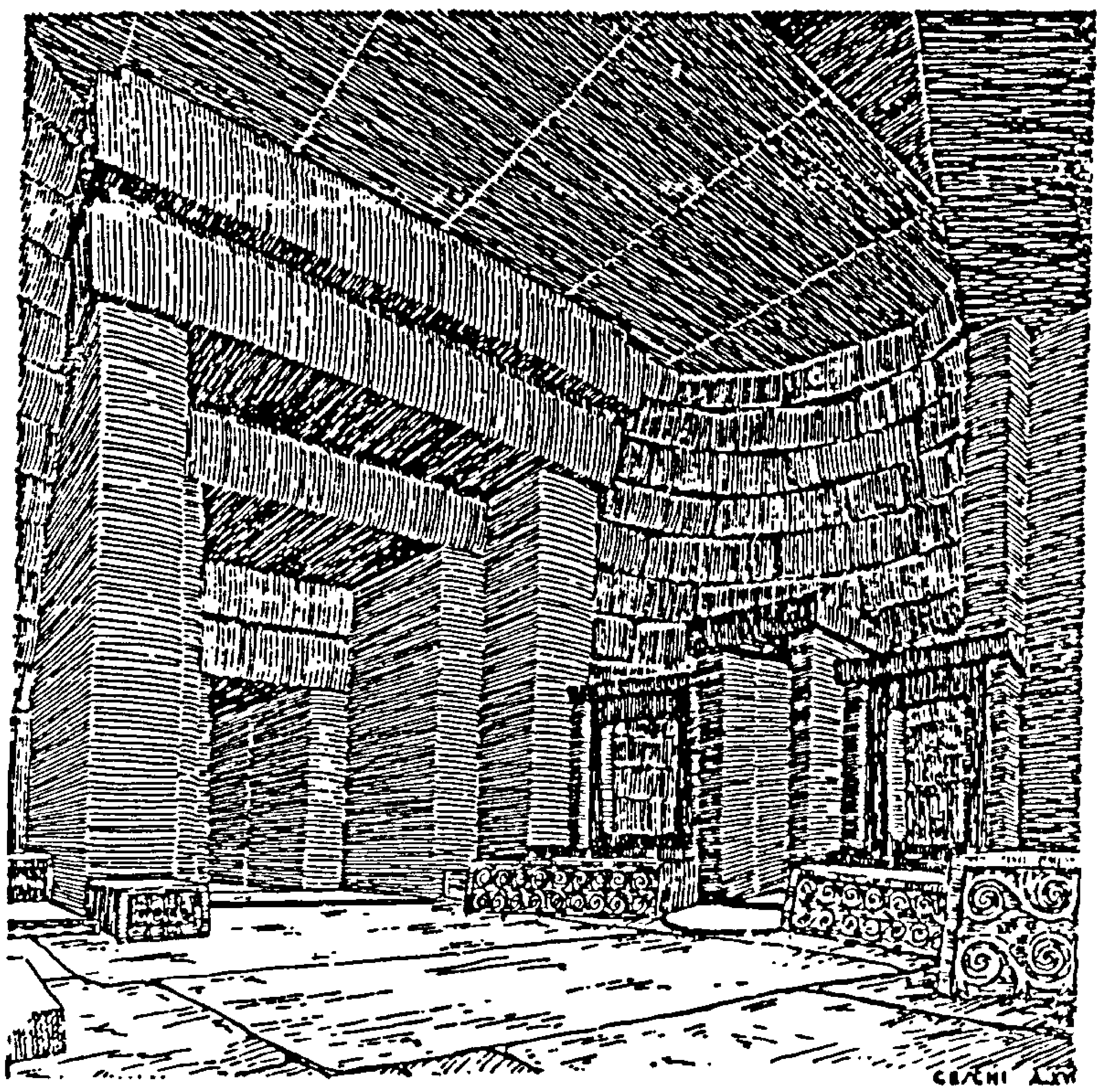


Fig. 4.23 Reconstruction Cella 1, Temple 1, Tarxien.

view of the gap to be bridged], 60cms broad and 80cms high, the tensile strength of the stone is adequate and the pressure on the walls, about 1kg/sq cm. The complete loss of the [roof] slabs can be explained by the decay in the mechanical properties of the material, and by [earthquake] shocks to the structure".

The third and last detailed assessment of roofing, is also Italian, by Piovanelli (1988). Piovanelli starts by saying that roofing should be considered in the context of the temples' function: doors could be locked for security or defence and so there must have been a roof. The author's view is that defence was unnecessary – no weapons of this period have been found – and a religious society hardly needed security, any more than Christian churches in a believing society did. Access may have been limited, but this was not a coercive limitation.

Piovanelli argues against Evans' idea of a wood-supported roof, on the grounds that it was not durable and that wood is more appropriate to rectangular, not "kidney" shaped buildings. This argument does not seem valid: wood can be perfectly durable if adequately protected from the elements by some form of covering and the "kidney" point seems irrelevant.

Piovanelli has doubts about the massiveness of Ceshci's reconstructions. He considers that, architecturally, there would have been more signs of the stones from the collapsed roofs. He suggests that it would be worthwhile to look again at the Hal Saflieni hypogeum (see Fig. 4.19). He further suggests that on top of the inwardly battered walls of an apse, were placed concentric rings of stone, which progressively reduced the space to be covered, and that this, more convincingly, corresponds to the form of the hypogeum. Thus, he suggests the scheme shown in Fig. 4.25 compared with Ceschi's, repeated for convenience in Fig. 4.24.

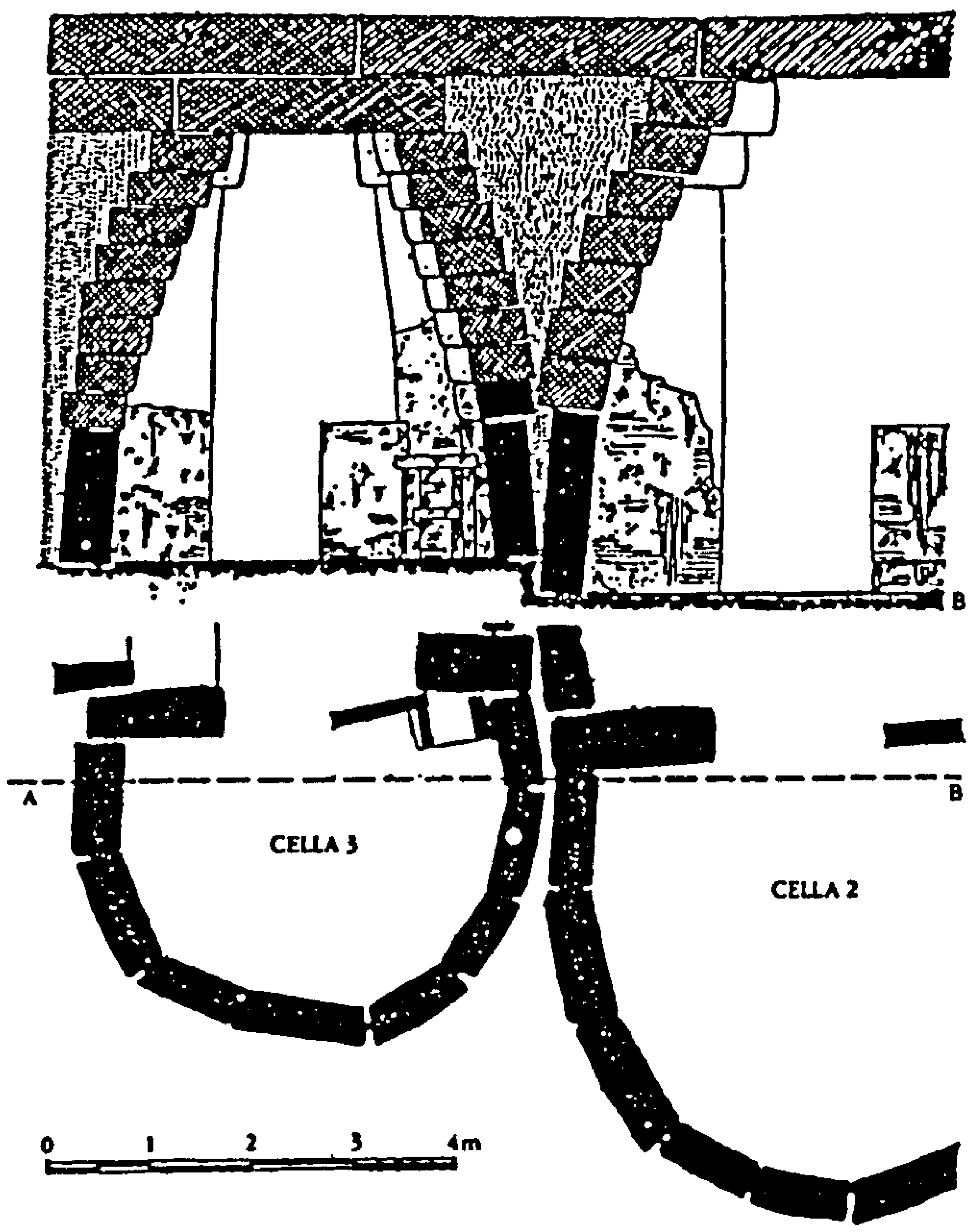


Fig. 4.24 Reconstruction of the roofing of two apses at Tarxien by Ceschi.

From Piovanelli (1988 : Fig 1) from Ceschi (1939 : Fig 33)

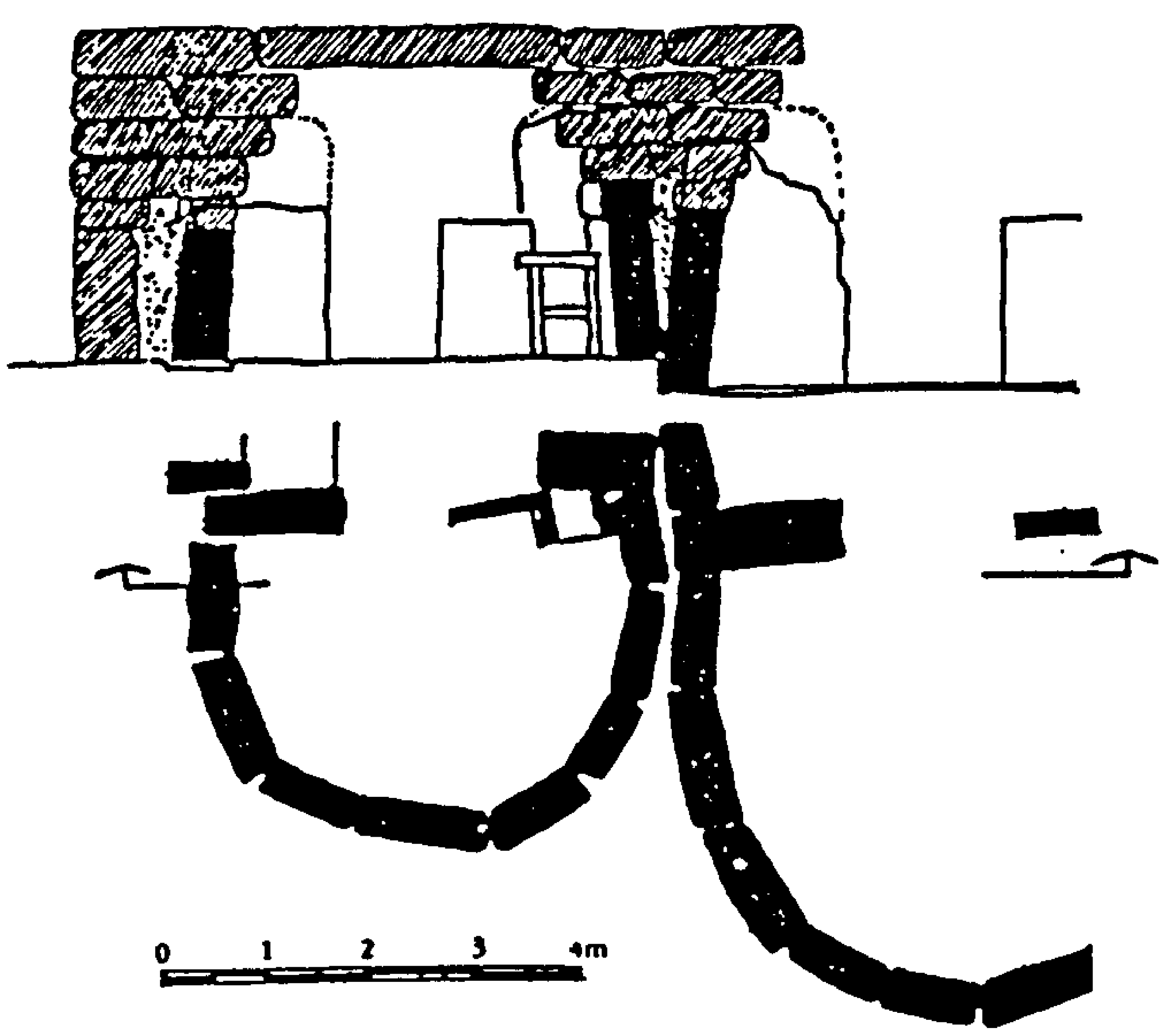


Fig. 4.25 Piovanelli's reconstruction of the same apses as Ceschi's above.

"The large saving in material is obvious, and so too is the structural interdependence of the whole system ... the modest size of these horizontal slabs ... may have led the first excavators to ignore their remains." (*op cit* : 130).

It is important to consider whether the physical properties of Globigerina limestone would allow construction of an edifice such as that postulated by Pollini. The author must here acknowledge the invaluable expert assistance of Mr. Rowland Morgan, Senior Lecturer in the Department of Civil Engineering, University of Bristol. On a visit to Malta and Gozo, in October 1996, Morgan and the author collected samples of Globigerina limestone. From these, Morgan cut four small beams 256 x 35 x 35mm and subjected them to a tensile test, to ascertain their flexural strength, also known as the Modulus of Rupture (d). Three beams cut from one sample produced an average d=N/mm^2 of 4.5, while the fourth beam, cut from another sample, produced the much lower figure of 1.9. The density of the material was 1.7 tonnes/cu m.

Morgan assumed that the length of beam necessary to span a temple apse was 6m (derived from measuring apses at Hagar Qim) and that in section, the beam measured 0.5m x 0.5m. By applying the appropriate formula, Morgan calculated that such beams could support their own weight. Further, that a beam with the higher Modulus of Rupture could support an additional load of 5 tonnes at its centre, and the one with the lower Modulus, a weight of 1.5 tonnes at the centre. Clearly, a greater load could be carried if it were distributed more equally over the length of the beam.

The result of this work is to demonstrate that the material strength of Globigerina limestone does not place a constraint on the possibility of roofing the temple apses with stone. It does not, of course, demonstrate that such a method was employed. This question is reviewed in the next section.

Evans (1959 : 126) represents the "British School's" standpoint when he states: "One very vexed question is whether, and if so, how the temples were roofed ... The grandiose, but rather specious, reconstructions published by the Italian architect Carlo Ceschi, just before the last war, have tended rather to discredit the idea that they were roofed, but I am rather of the opinion that they must have been, though in a more modest manner than that imagined by Ceschi, no doubt."

In favour of some form of roofing, Evans (*op. cit.* :128) points to the excellent condition of the Globigerina limestone furnishings when Tarxien was first excavated and contrasts this with the degradation of the modern copies and cites this as evidence for roofing – including the central spaces as well as the apses.

Despite the inward overhang of the apse walls, Evans rejects a corbelled dome on the grounds that it was impossible for a semi-circular structure. He cites, like others, the Mgarr model (Fig. 4.26) repeated for convenience, showing horizontal slab roofing,

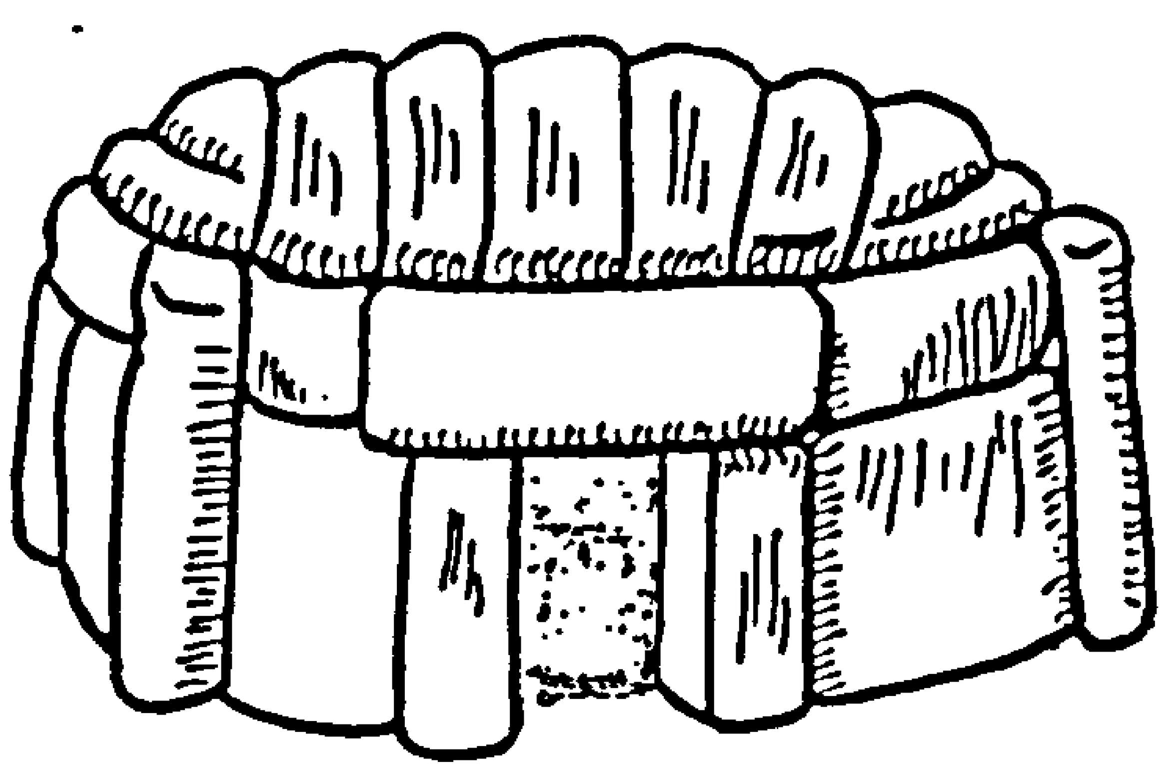


Fig. 4.26 Model temple from Mgarr

and also the "graffito" relief on a wall at Mnajdra, Fig. 4.27.

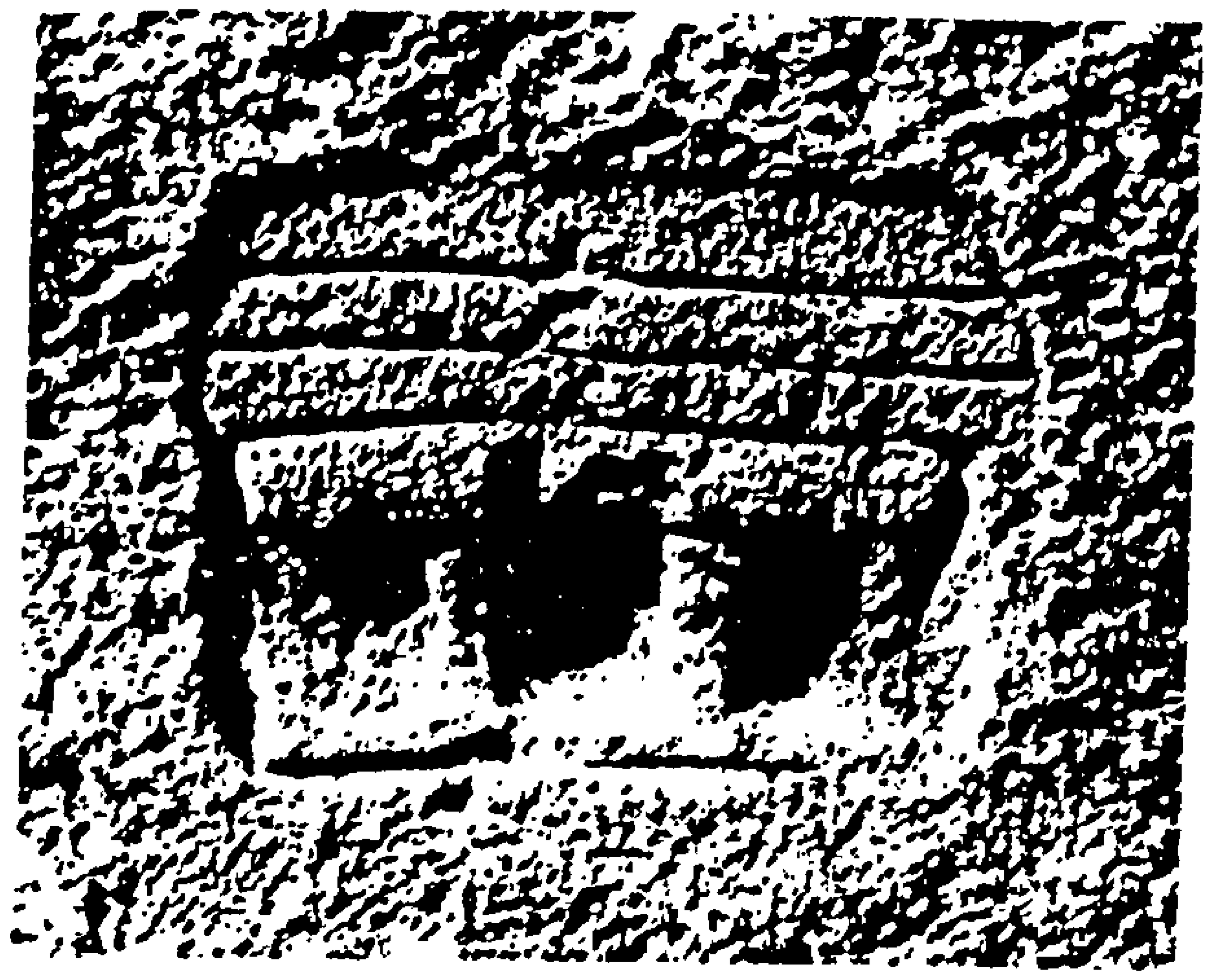


Fig. 4.27 Wall relief of a temple at Mnajdra.

After referring to the hypogeum at Hal Saflieni, Evans says "An exactly similar form of roofing is used today in some of the Maltese farmhouses, but it is only feasible for rooms of strictly limited breadth. About 8ft is the maximum span which can be covered by a slab of Maltese limestone, without introducing central supports." (*op. cit.* : 127). (But see preceding section.) Despite corbelling, says Evans, the apse spans are far greater than this. "Personally, I am inclined to think that it [the roofing] was done with wood. Suitable wood is now scarce in the Maltese islands ... Yet in prehistoric Malta, there may well have been a sufficient supply on hand." (*op. cit.* : 128).

"One feature of the Tarxien temples could be interpreted as positive evidence in favour of wooden roofs. This is the sign of intense burning, visible on the walls of the middle temple at Tarxien. The conflagration that caused them evidently happened while the temple was still in use, since they go below the present floor level. What was there in the temples to burn so furiously – unless they were roofed with wood?." (*op. cit.* : 127-8).

Evans argues that "A completely domed structure seems unlikely, for a number of reasons. It seems highly improbable that such a structure could have been made using the techniques employed in building the earlier temples [eg. Ggantija]. ... The true corbelled vault is circular in plan and is given solidity by the mutual pressure of its component parts on each other ... the semi-circular course of corbelled blocks in the temple, has to be held at each end by a tall pillar-like slab, which, however, was only high enough to serve four or five courses of blocks. Above this level, the roof, if it existed, must have been flat." (*op cit.* : 127).

In confirmation, he looks at the model from Mgarr (Fig. 4.26) and the relief carving from Mnajdra (Fig. 4.27)

Evans' major (1971) work is descriptive, rather than speculative and he does not consider roofing. Trump (1966) has various comments on this matter. Trump's work is primarily about his excavations at Skorba on Malta. Of the earlier (Ggantija) phase he says (p.5): "no direct evidence was found on how the building was roofed at this time". Of the Tarxien phase, he says: "Evidence for roofing was slight but important in view of its extreme scarcity on other sites. It is clear that masonry as rough as that in the apse walls here [ie. Skorba] could never have supported the weight of a corbelled vault in stone. Its roughness excludes equally, the horizontal arch ... a device certainly employed in later temples. Any roofing must have been in some lighter construction. In part of the west apse, the stratigraphy in the 15 or 20cms above the floor, was illuminating. Immediately overlying the torba was about 8cms of hard, compacted grey clay, an accumulation of trampled dirt on the floor, as everywhere else in the building. Between this and the stone and dust filling of the temple ruins, was a sterile level of crumbled orange clay. This is presumably the decayed remains of a roof of clay-on-brush." (*op. cit.* : 6-7).

In a footnote, Trump notes:

"A good example of later date was excavated in 1960. A defence tower of the third century AD ... had been roofed with beams, brush, clay and plaster. The fire which destroyed it, had preserved the first three as charcoal, ash and poor terracotta in the lowest debris inside the building." (*op. cit.* : 7). It may be presumed that by this footnote, Trump wished to imply that the orange remains referred to in the previous paragraph, were the result of fire, though he does not say so.

At the end of Trump's volume, an appendix (v.) by C.R. Metcalfe, identifies charcoal samples as being of wild or domesticated olive, and Metcalfe comments "the samples came from the destruction level of the temple (Tarxien phase) and must represent the timberwork of its roof. The implication is that they were from well grown olive trees, not from the wild scrub olive." In the pre-temple Ghar Dalam phase, samples of *Cercis siliquastrum* and possibly of *Crataegus* sp. and *Fraxinus* sp. were found.

The question of the availability of timber is reviewed in Chapter 5 : the author's conclusion therein, is that there is no reason to suppose lack of availability.

The literature on roofing has been reviewed at some length because this is a very vexed problem. What conclusions may be drawn?

Bonnano (1988 : 110) briefly reviews the position and concludes:

- That the temples were roofed.
- How were they roofed? He states that the archaeologists say by beams covered with branches and clay and the architects say with stone slabs, thus putting the two in "different camps. As an archaeologist, I will be convinced of the version confirmed

by experiment. This is an ideal opportunity for a little experimental archaeology."

It will be noted that Ceschi, Tampone and his colleagues and Piovanelli all thought that Globigerina limestone beams could be used to span a 5m gap. This view was confirmed by Morgan. Evans incorrectly thought 8ft (2.5m) was about a maximum.

All the authors quoted believe temples were roofed, for the reasons given. This view should be accepted. As an additional pointer, it may be noted that when considering the apse walls at Ggantija, later in this chapter, it will be found that they were plastered and probably painted, a treatment that would not have lasted if exposed to Malta's sometimes torrential storms.

4.7 <u>HOW WERE THE TEMPLES ROOFED</u>?

From the outset, we should not assume that they were all roofed in one way. It is perfectly possible that as architectural and constructional skills became more sophisticated, roofing methods changed. The later temples (Tarxien, Hagar Qim) built of Globigerina, could have been roofed with stone slabs as suggested by Piovanelli. Although the author is inclined to think that this was not done, for the reasons advanced by Evans, ie. at Tarxien, signs of strong conflagration and lack of damage to furnishings. Even in these temples, a timber based roof, seems more likely.

Turning to Ggantija, the main centre of our interest, even cursory examination of the apse walls shows that they could not have withstood the pressures that would have been involved with a stone roof. (A view held by Trump, as has been seen, in respect of the similarly constructed Skorba.) Ceschi and Tampone and his colleagues, both show reconstructions of the apse wall of Ggantija as if they had been constructed of dressed ashlar blocks : they were not. The crude Coralline limestone blocks used in the apses' construction are much the same as they were when originally built. Had Ceschi and Tampone and colleagues allowed for this, it seems doubtful whether they would have advanced their propositions that Ggantija had a stone roof.

In rejecting the idea of stone roofing, it should be said that we are ignoring the apparent evidence of the model temple from Mgarr (Fig. 4.26). Is this reasonable? It is very likely that smaller shrines, as well as the larger temples, were constructed by local village communities. If so, roofing them with stone blocks in the way shown in the model, would have been a logical building technique. It was somewhat similar to the method employed, until recently, in the construction of Maltese giren, which are huts for sheltering livestock or shepherds, with corbelled walls surmounted by stone slabs (covered by smaller stones) (Fsadni 1992). Shown in Figs. 4.28 and 4.29 is a large girna at L-Ahrax ta Gewwa on Malta. It has an external diameter at the base, of about 5.5m and an internal diameter of 3.5, ie. the walls are about 1m thick at this point, and the overall height is 2.7m. Fig. 4.29 shows the corbel construction and it will be noted that this narrows rapidly to the apex, requiring only relatively small, flat slabs for its completion, and thus somewhat different from the Temple Period models.

The fact that small buildings were so constructed, does not mean such a technique could, or would have been extended to the larger temple structure.

So, the conclusion is that probably all the larger temples, certainly Ggantija, had timber supported roofs. These may have been covered with brush and some rainproof top layer.

That leaves a major question. Malta can suffer torrential storms. What happened to the water?

Fig. 4.28 Exterior of a girna at L-Ahrax ta Gewwa

Fig. 4.29 Interior of the above girna

The areas to be covered are large. At Ggantija, the largest apse is some 10m across at its widest point. One possibility is that only the apses were roofed. This presents two problems:

1. Where did the rainwater go? If it was directed to the central aisles, they would, at times have been awash with water and their morphology gives no indication of being designed to deal with such a situation.

2. If the rainwater was directed towards the inter-wall rubble infill, and this was not covered, then hydraulic action would have tended to wash down the smaller components and put pressure on the torba surfacing of the apses, pushing it off.

The other possibility is that the whole temple complex was roofed over, and that the rainwater was directed, in some way, over the perimeter wall. The South Temple at Ggantija, is nearly 30m from front to back and more from side to side. A pitched roof, with an eaves height equal to part of the surviving wall, would need a much higher central ridge, this height depending on the nature of the weather proof outer layer.

There was a durable weather proof material available to the temple builders, one that could be used at low angles, namely torba. Torba is ground up Globigerina limestone, which when mixed with water, can be applied as a plaster. Applied in several layers and allowed to dry between applications, it forms a very durable surface. It was used on the apse walls and on parts of the floor at Ggantija (and is also in other Maltese temples). Its durability is demonstrated by the continued presence of such floors, open to the elements, certainly since clearance early in the last century.

The author's hypothesis is that torba was employed in the roofing of Ggantija. Its properties would also allow the construction of guttering, by being used to waterproof the inside surfaces of Globigerina slabs, forming the gutter. See Fig. 4.30 for a schematic representation. If such guttering were employed between the apses, the roofing over the apses could be pitched, at a fairly low angle, to drain into such guttering, which, in turn, could slope gently down to drain over the perimeter wall. Over the apses, the roof could be of fairly large timbers. In turn, covered successively by smaller timbers, then daub (earth and small stones) and torba. Fig. 4.30 demonstrates the scheme. Over the rubble infilling it would only be necessary to make a surface of daub, covered with torba. Fig. 4.31 shows a plan of the way such guttering might be employed. Other configurations are possible, but if some such method were employed, it would give a fairly flat, external appearance to the top of the temple, which would correspond to the character of the model temple and graffito already referred to (Figs. 4.26 and 4.27), and thus not detract from the imposing temple façade.

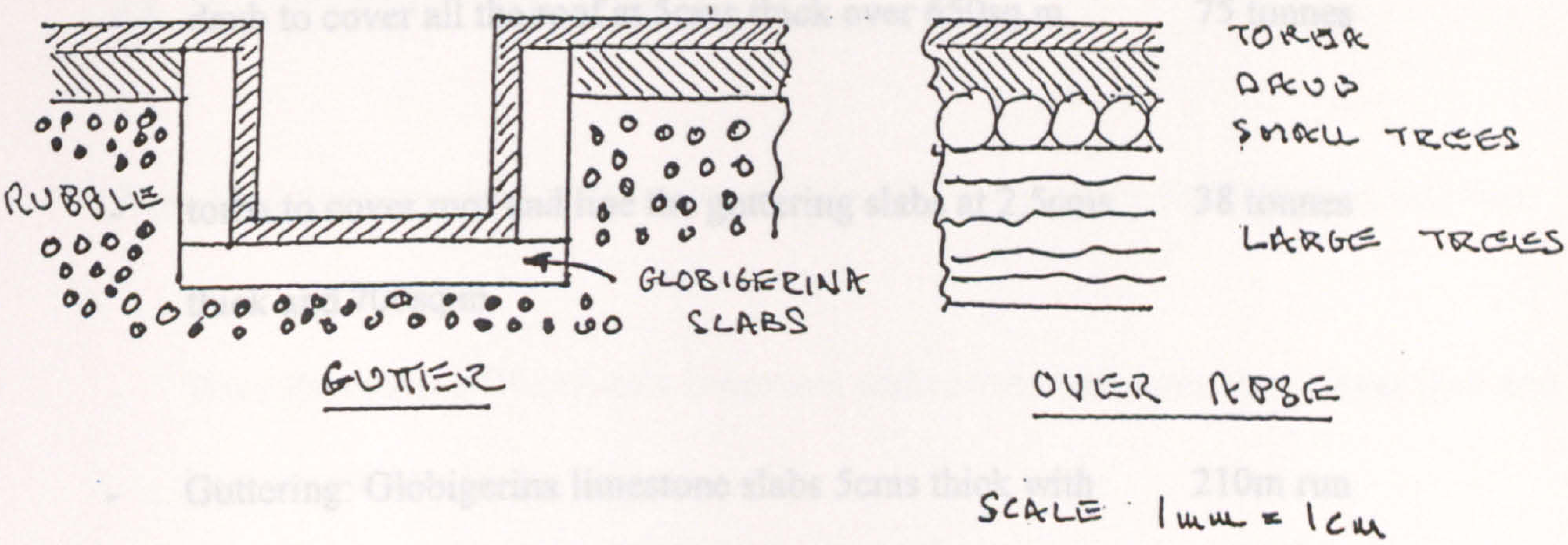


Fig. 4.30 Section through temple roof

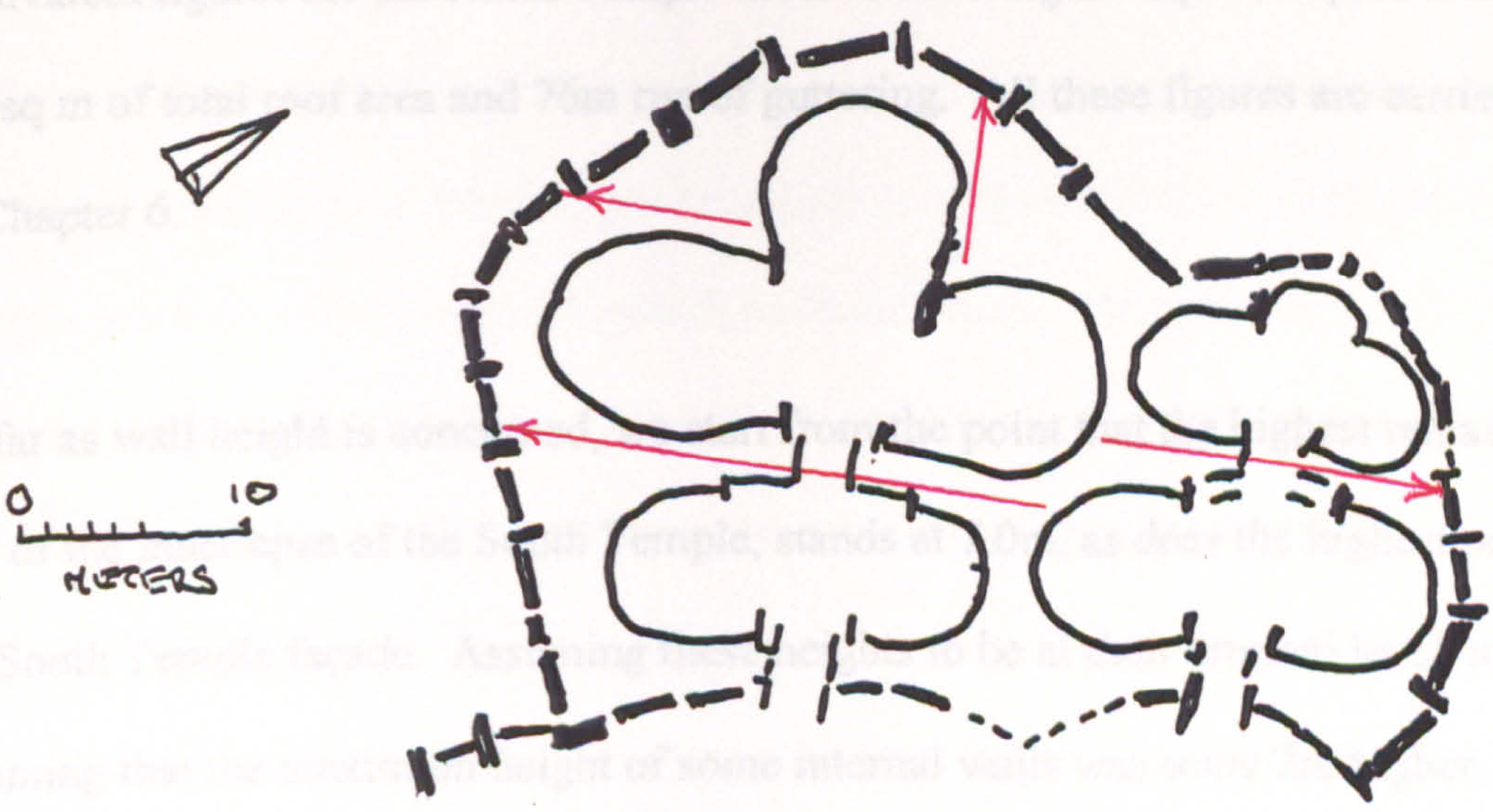


Fig. 4.31 Plan of roof guttering and drainage direction.

Given this conjectural roofing, the material requirements for the South Temple would be as follows:

-	large timbers to roof 5 apses and the central aisle: up to 17cms in diameter and 6m long	384sq m equal to 384 trees
-	small branches to cover the above: up to 5 cms in in diameter and 2.5m long	384sq m equal to 3072 branches
-	daub to cover all the roof at 5cms thick over 650sq m	75 tonnes
-	torba to cover roof and line the guttering slabs at 2.5cms thick and 700sq m.	38 tonnes
-	Guttering: Globigerina limestone slabs 5cms thick with a wall height of 20cms and a base 40cms wide	210m run equal to 15 tonnes

Equivalent figures for the North Temple involve covering 234sq m of apses and aisle, 400sq m of total roof area and 76m run of guttering. All these figures are carried forward to Chapter 6.

As far as wall height is concerned, we start from the point that the highest remaining wall, that of the inner apse of the South Temple, stands at 7.0m, as does the highest portion of the South Temple façade. Assuming these heights to be at their original level, and assuming that the maximum height of some internal walls was some 2m higher, to allow for the necessary pitching of roofs, we arrive at an average height of apse walls, of 8m and for the perimeter wall, a height of 7m.

We can assume that these dimensions apply to both south and North Temples, although the latter may have been somewhat lower.

In the sensitivity analysis in chapter 6, allowance is made for the possibility that all the heights given above, may have been greater.

Finally it may be noted that the roof postulated would not have left much debris when destroyed by fire or otherwise, nor damaged the temple's furnishings significantly.

4.8 PLASTERING THE APSE WALLS

Were the interior apses of the temples plastered? This question really divides into two:

- Were the dressed Globigerina limestone walls of the later temples – Hagar Qim and Tarxien plastered?
- Were the undressed Coralline limestone walls of earlier temples – Skorba and Ggantija plastered?

At Tarxien, Zammit (1917 : 272) found the use of white mortar to fill the interstices between building blocks, that led him to suggest that the walls were plastered all over and perhaps painted with red ochre, of which he found traces. However, he found no traces of surviving plaster. Evans (1971 : 130) finds it hard to believe that the accurately cut and beautifully finished slabs "... were intended to be completely covered up."

At Ggantija, the position is very different. The apse walls are built of undressed Coralline limestone blocks, of varying size. Evans states (1959 : 107): "there is some evidence that the rugged chamber walls were concealed by a thick layer of daub, faced with a thinner layer of limestone plaster" [torba].

Specimens of the daub and plaster are in Valetta museum. The plaster on top of the daub is 0.5cms thick and covered with a red ochre pigment (Evans 1971 : 175), although later (p.185) he says the plaster is 5cms thick – surely a typographical error – no-one plasters that thick on a reasonable base).

Fig. 4.32 shows a photograph of some remaining daub in the first apse on the left of Ggantija South Temple.

Fig. 4.32 Apse wall daub at Ggantija.

Fig. 4.33 is a painting by Brocktorff (whose name is spelt variously) made in the 1820s, shortly after the original clearance. This shows imperfectly smoothed walls, which perhaps allows some confirmation of Evans' analysis:

Fig. 4.33 Painting of Ggantija by Brocktorff.

Trump (1966 : 5,8) reported on his excavation of the temples at Skorba, and found similar traces of plastering. Walls built of undressed medium sized "cyclopean" Coralline limestone, had their interstices packed with similar rubble, which was then plastered and painted with red ochre. Tampone and his colleagues (1987 : 18-19), report on their investigations of "so-called plaster" of the apse at Ggantija. A portion was extracted for inspection which "was in the process of falling off". This sample was of the daub, above-mentioned and was analysed in detail and found to consist of clay, silt, sand and gravel in varying proportions. (This corresponds to a visual inspection of those parts remaining, which have not "fallen off", see Fig. 4.32). Tampone and colleagues, go on to speculate that this daub was then covered with a white plaster, (but not lime in the sense of burnt limestone) as Evans and Trump would also have it. Alternatively, it acted as a base for thin slabs of Globigerina limestone: an idea they find attractive. Such tiling was certainly possible, but as no signs of it have been found, and Evans found signs of plastering, his proposition is preferred.

We may now turn to the quantities involved.

The blocks used in the apses of Ggantija are extremely rough. If one assumes that the blocks are hemispherical in outer prospect, then approximately 0.009cu m of daub is required per sq m. If, in addition, one supposes that the daub extended a further 2cm, then 0.029cu m per sq m, is required, equal to 0.06 tonnes per sq m.

Let us assume that Evans' figure of 0.5cms of plaster is correct, then 0.005cu m per sq m is required.

The horizontal linear length of the five apses of the South Temple (omitting door jambs etc.) is 96m and that of the North Temple is 75m. Multiplying these figures by the presumed height, will give us the material requirements (see later in this chapter).

4.9 PAINTING THE APSE WALLS

Evans (1971 : 175) says that on the torba plastering of the Ggantija apses: "there were abundant trances of red paint". This echoes the use of red ochre in the Hal Saflieni hypogeum. It may well have been the case that the torba floors were similarly painted: certainly, this was so in parts of the Ggantija period at Skorba (Evans 1971 : 37). Zammit (1912), found traces of red ochre at Tarxien, though whether on walls or floor, is not clear. No reference to the provenance of red ochre has been found, but it is not available on the Maltese islands, and must have been imported from Italy or Sicily. Labour requirements would, therefore, have involved procuring it, shipping it, grinding it up and applying it. I do not have any means of estimating the energetics involved and have, therefore, suggested a very arbitrary figure of 0.4 litres per sq m of a mixture, of 1 part red ochre solids to 10 parts water. The areas to be covered are as for plaster, given above (walls and floors).

4.10 FLOORING THE TEMPLES

It is clear from the existing remains, that the interior of the temples were floored, in part, by stone paving and in part by rubble and earth, surfaced with torba. Stone slabs were used for the temple entrances and for part of the internal aisles in the temples, as is apparent from Evans' plan (Fig. 4.2). They were typically about 20cms thick, laid on a rubble foundation, and in Ggantija, were of Coralline limestone.

Evans (1971 : 180) reports on four trenches dug at Ggantija in 1954. Trench A was cut in apse 6 of the South Temple (see Evans' plan Fig.4.2). A layer of torba 6 cms thick lay over a thin layer of earth, in turn over a packed layer of stones. As the earth contained both Ggantija and Tarxien period potsherds it may be that the original floor was the layer of stones subsequently re-floored with torba in the Tarxien period. Trench B in apse 3, had a layer of torba over stones containing Ggantija sherds. The other two trenches were taken out in the North Temple. Trench C in room 14, had a remarkably thick torba section, 25cms, containing Ggantija period sherds. Finally, trench D in apse 9, had a thin earth layer containing Tarxien type pottery, below which was a thin torba layer over a compacted layer containing Zebbug and Ggantija period sherds.

There are considerable variations in the thickness of both rubble infill and of the torba surfacing. Rubble infill varies from a few centimetres to 60cms, (eg. at Tarxien) and the torba surface from as little as 2cms (in parts of Ggantija), to as much as 25cms (also at Ggantija). The floors of both the south and North Temples at Ggantija, slope downwards towards their entrances, following the natural slope of the land. So extensive infilling was unnecessary. As a reasonable estimate, an average rubble infill thickness of 30cms and torba thickness of 5cms, has been taken.

Areas and volumes involved are:

<u>South Temple</u>

Rubble infill				
Apses	220sq m			
Aisles	15sq m			
	235 x 0.3m thick		=	70
Under paving slabs	45 x 0.1		=	4.5
				75.0cu m
Torba				
Apses and aisles	235 x 0.05		=	12cu m
Paving				
Aisles	45 x 0.2		=	9cu m

<u>North Temple</u>

Rubble infill				
Apses	99sq m			
Aisles	33sq m			
	132 x 0.3m thick		=	40
under paving slabs	16 x 0.1		=	2
				42cu m
Torba				
Apses and aisles	132 x 0.05		=	7cu m
Paving				
Aisles	16 x 0.2		=	3cu m

4.11 THE TEMPLE PORTALS

The entrance to the temples and the passageways, through from the outer pair of apses to the inner two or three, had impressive monolithic jambs and lintels. No lintels remain at Ggantija, but those at Hagar Qim (modern re-erections but plausible see Fig. 4.34) and at Tarxien, and also the model and graffito, previously referred to, all give an idea of their magnificence.

Fig. 4.34 Hagar Qim Façade

Evans' (1971) plans and sections give an idea of the layout and size of the jambs at Ggantija.

The South Temple Portals

Several of the existing jambs were measured by the author, as marked on Evans' plan. See Fig. 4.35.

The dimensions are given below. It will be noticed that all but two are of dressed Globigerina limestone, and the two Coralline limestone monoliths are, in fact, upright stones not serving as portal jambs. This is true throughout the two temples: (see below)

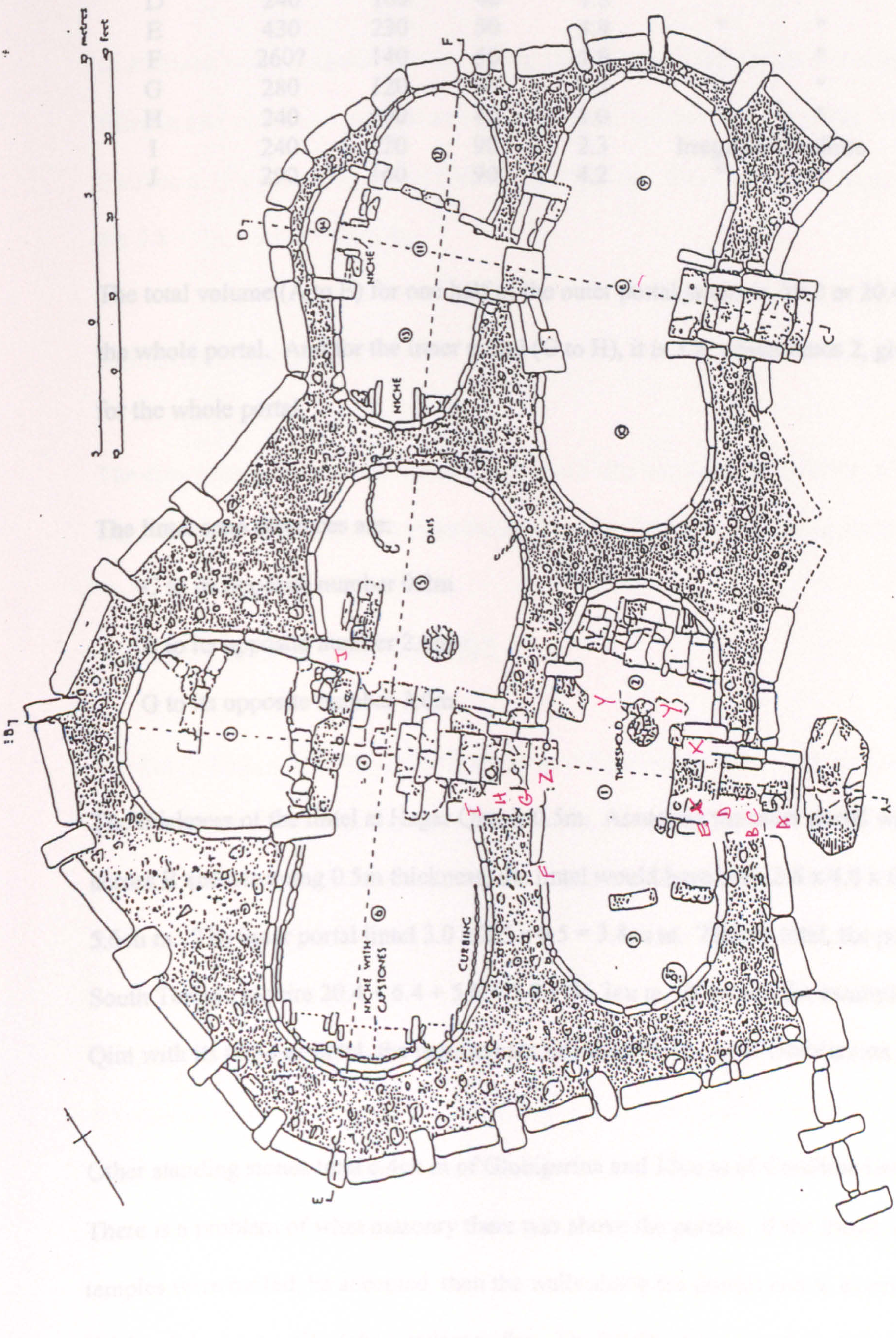


Fig. 4.35 Measured dressed stones at Ggantija

Monolith	Height cms	Width cms	Depth cms	Volume cu m	Material	Area to be dressed sq m
A	290	150	60	2.6	Dressed Globigerina	14
B	250	70	40	0.7	" "	6
C	190?	70	35	0.5	" "	5
D	240	160	40	1.5	" "	11
E	430	230	50	4.9	" "	26
F	260?	140	50	1.8	" "	11
G	280	120	65	2.2	" "	12
H	240	100	40	1.0	" "	8
I	240	120	90	2.3	Irregular Coralline	Total 93
J	290	160	90	4.2	" "	

The total volume (A to E) for one half of the outer portal jambs is, 10.2 or 20.4cu m, for the whole portal. And for the inner portal (G to H), it is 3.2, which times 2, gives 6.4cu m for the whole portal.

The lintel span distances are:

C to its opposite number 0.2m

B to its opposite number 2.8m

G to its opposite number 3.0m

The thickness of the lintel at Hagar Qim is 0.5m. Assuming the outer portal was spanned across B and assuming 0.5m thickness, the lintel would have been 2.8 x 4.0 x 0.5 = 5.6cu m. The inner portal lintel 3.0 x 2.5 x 0.5 = 3.8cu m. Thus in total, the portals of the South Temple require 20.4 + 6.4 + 5.6 + 3.8 = 36.2cu m. If we use the example of Hagar Qim with its two-tier lintel, the requirement becomes 45.6cu m of Globigerina limestone.

Other standing stones total c.4cu m of Globigerina and 13cu m of Coralline limestone. There is a problem of what masonry there was above the portals. If the theory of how the temples were roofed, be accepted, then the walls above the portals had to extend to the height of the apse walls, taken earlier as 8m. The height of the top of the lintels averages nearly 4m, so an additional 4m is required. The additional masonry and rubble required, assuming outer walls with rubble infill, would have been 4 x 2.8 x 4 + 4 x 3.0 x 2.5 = 75cu m, of which 23cu m is stone walling and 52cu m is rubble infill.

In addition, we can assume that the visible inside walls of the portals above the lintels were filled in and surfaced with daub and then plastered, as were the apse walls. This required 0.029cu m of daub per sq m and 0.005cu m of plaster. The total area to be so covered is 4 x 2.8 + 2 x 4 x 3.0 = 36sq m.

The North Temple Portals

The dimensions of the North Temple portals are very similar to those of the South Temple and it is reasonable to use the same calculations for the North Temple as for the south.

4.12 THE TEMPLE FURNISHINGS

The South Temple is furnished with some carved, decorated stones. These are not built into the structure, but stand upon the floors, with the one exception of a threshold slab between the outer and inner pairs of apses. All these stones are still visible but their decoration has deteriorated badly.

There are two blocks, 45cms in each dimension, at the rear of the portal entrance to the first pair of apses. In each case, two sides are decorated with shallow drilled holes 0.7cm in diameter, separated by 3 cms, and they have a raised border on the decorated surfaces (Evans 1971, and author's observation). The blocks are identified as x on Fig. 4.35.

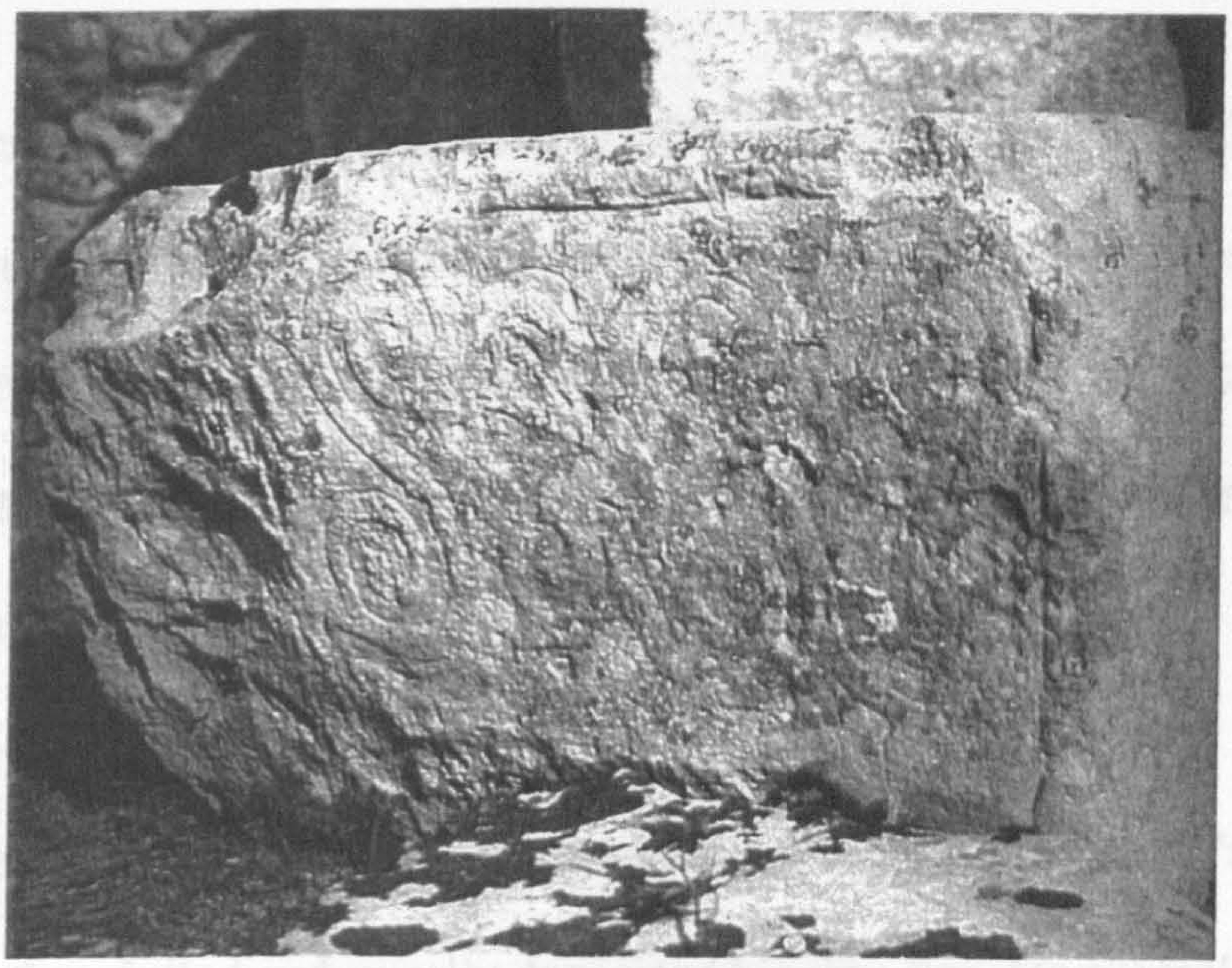


Fig. 4.36 Ggantija : Right-hand spiral slab of Apse 2; end.

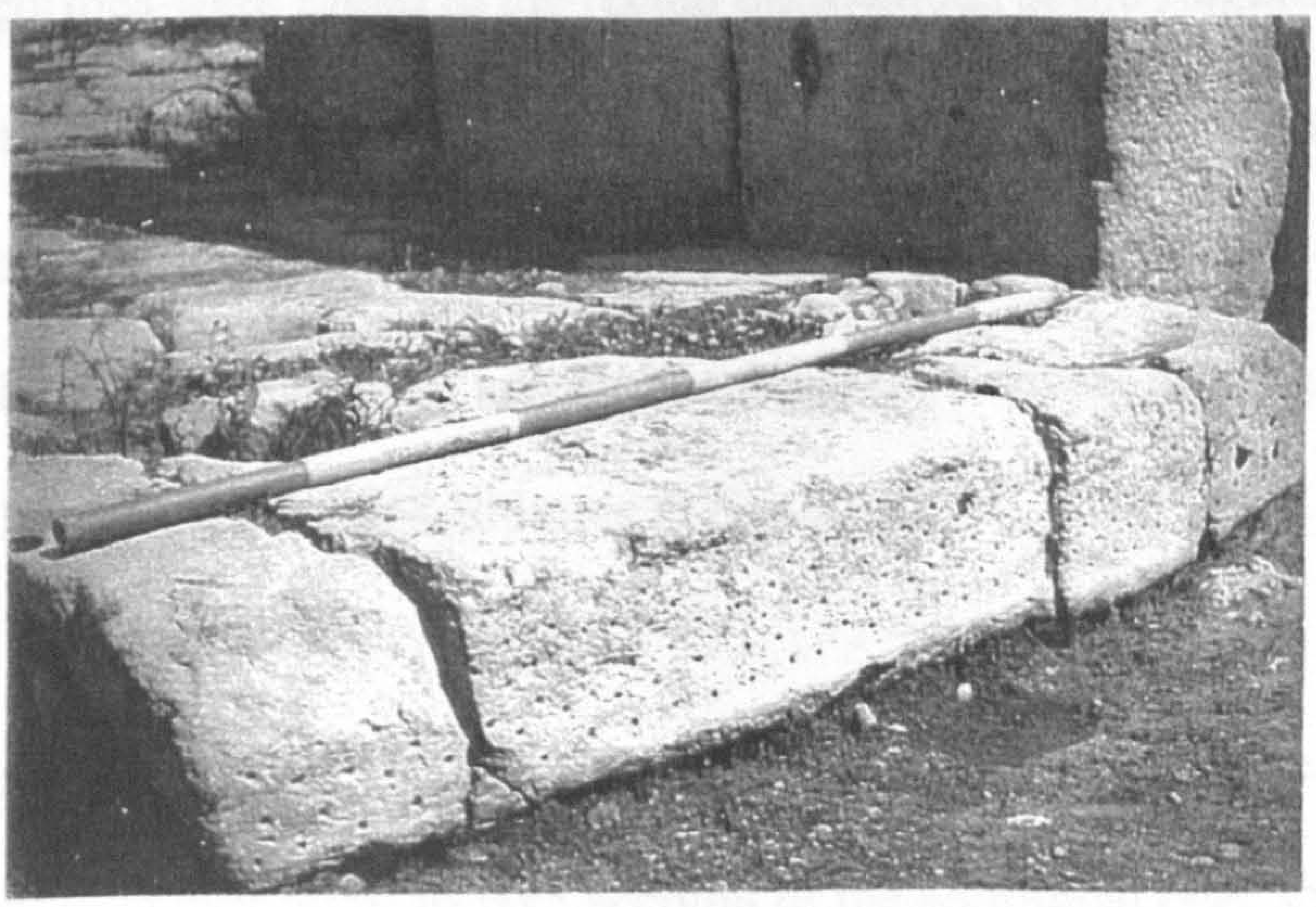


Fig. 4.37 Ggantija : Threshold slab of entrance to Room 4.

In the first apse to the right, are two blocks forming a kind of screen. Each are about 1.3m long and 0.7m wide and 0.5m high, on which is carved a running spiral decoration on one side and one end (Y on Fig. 4.35) Fig. 4.36 illustrates this.

The threshold slab (Z on Fig. 4.35) is 2.0m long, 0.3m thick and 1.2m wide and has a drilled surface on its visible eastern side, similar to the blocks described above Fig. 4.37 illustrates this. Finally, in the rear right hand apse, was a slab 135cms long, 60cms wide and 30cms thick, on the edge of which, was carved a snake in low relief (now in Gozo museum).

That these were not the only furnishings is indicated by Brocktorff's paintings, which show some further drilled and spirally decorated blocks. See, for example, Evans 1971: plate 29.

No relief carvings, nor three-dimensional sculptures remain, other than the snake mentioned above except possibly two unprovenanced Globigerina limestone heads. (Evans 1971 : 184 and Plate 62). Temples of the Tarxien period, especially at Tarxien itself, and also for example, at Hagar Qim, have numbers of both. A number of carved stone figurines were found in the recent excavations at the Xaghra Stone Circle, the hypogeum on the same plateau as Ggantija (Pace :1996). One "statue menhir" is dated to the Zebbug phase (c.4100-3800 BC). The others, in reports made so far, have not been dated. But in the absence of any archaeological evidence, it is assumed that there were no further three-dimensional sculptures at Ggantija.

For the purposes of the energetics analysis, the figure used for decorated blocks is that for those surviving plus 50%, to take account of the additional ones shown by Brocktorff. This may be an underestimate. Tarxien temple shows much richer and more abundant furnishings of blocks with drilled holes, spirals and animal reliefs. Whether this is the result of the systematic excavation by Zammit in the early years of this century, compared with the unrecorded "clearance" of Ggantija in the early years of the last, or a genuine reflection of the relative paucity of furnishings at Ggantija, we shall never know. It is noteworthy that there are no remaining carved furnishings in the Ggantija North Temple. Whether this is because there were none, or the result of clearance, is not clear. It is, of course, possible that the carved furnishings in the South Temple were placed there in the Tarxien period, well after Ggantija was built. For the purposes of the energetics analysis it has been assumed that they were placed there at the time Ggantija was built.

Thus we have:

Smoothed blocks surface area	15.7sq m
Relief carvings surface area	2.8sq m

4.13 THE PLATFORMS OUTSIDE THE TEMPLES

It was customary outside each temple, to have a more or less semi-circular level terrace, presumably for the people to assemble at times of cult practice. Remains of such terraces may be seen at Tarxien, Hagar Qim, Mnajdra and Skorba, as well as Ggantija. The remaining terrace at Ggantija is huge and is roughly delineated by the line A-A-A on Fig. 4.38.

Evans excavated a sample trench in the retaining wall in 1954 and reports on it in Evans 1971 : 179-81. His sectional drawing is shown in Fig. 4.39. He remarks on the "surprising feature" that the retaining wall rested on a bed of soil deposit about 1m thick. The wall contains a considerable quantity of Tarxien sherds and Evans (1971 : 181) concludes: "thus it was established beyond doubt that the platform had been completed some time after the completion of the temple complex, presumably at an advanced stage of the Tarxien phase, when the considerable deposit ... had accumulated".

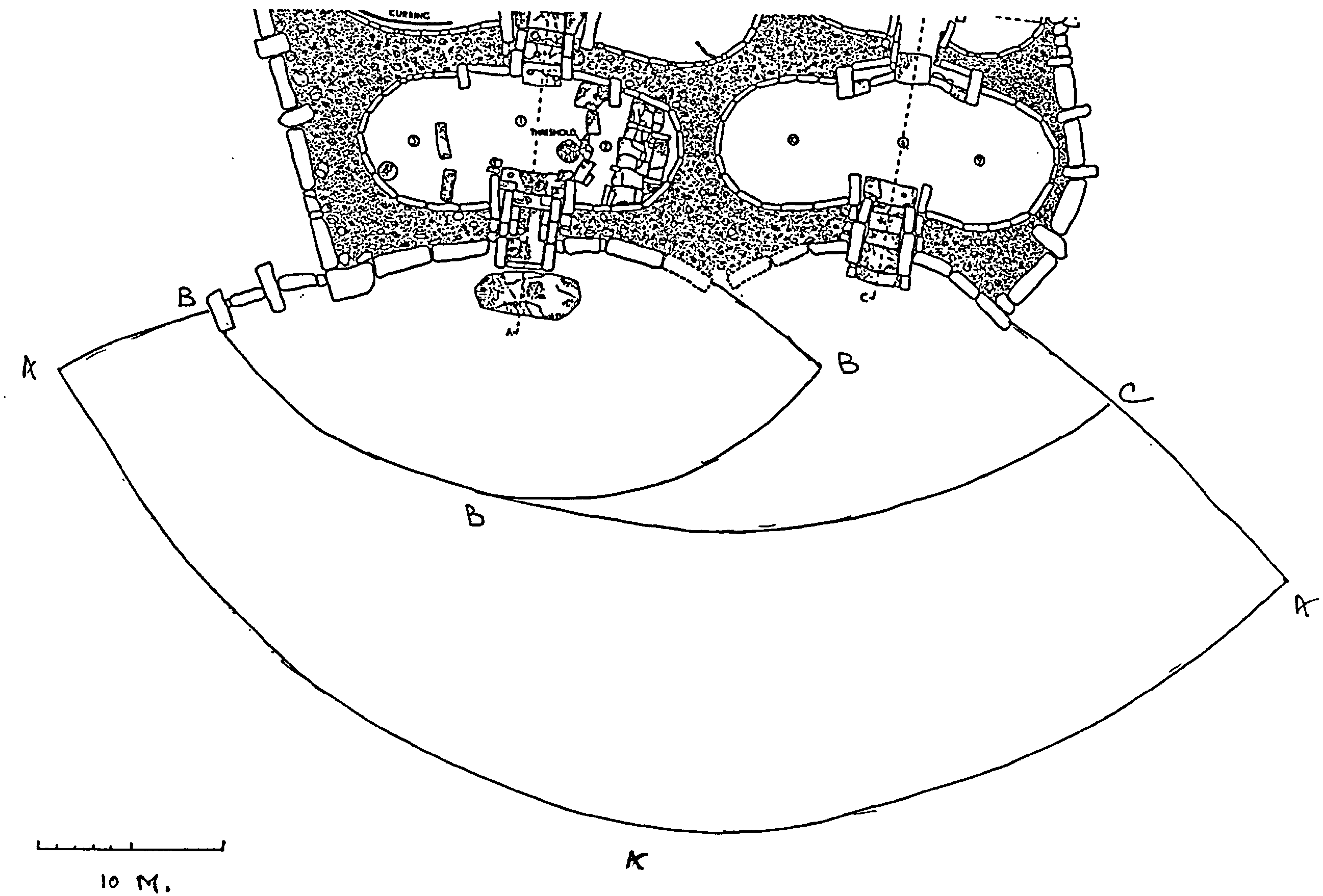


Fig. 4.38 Ggantija : The platform sequences

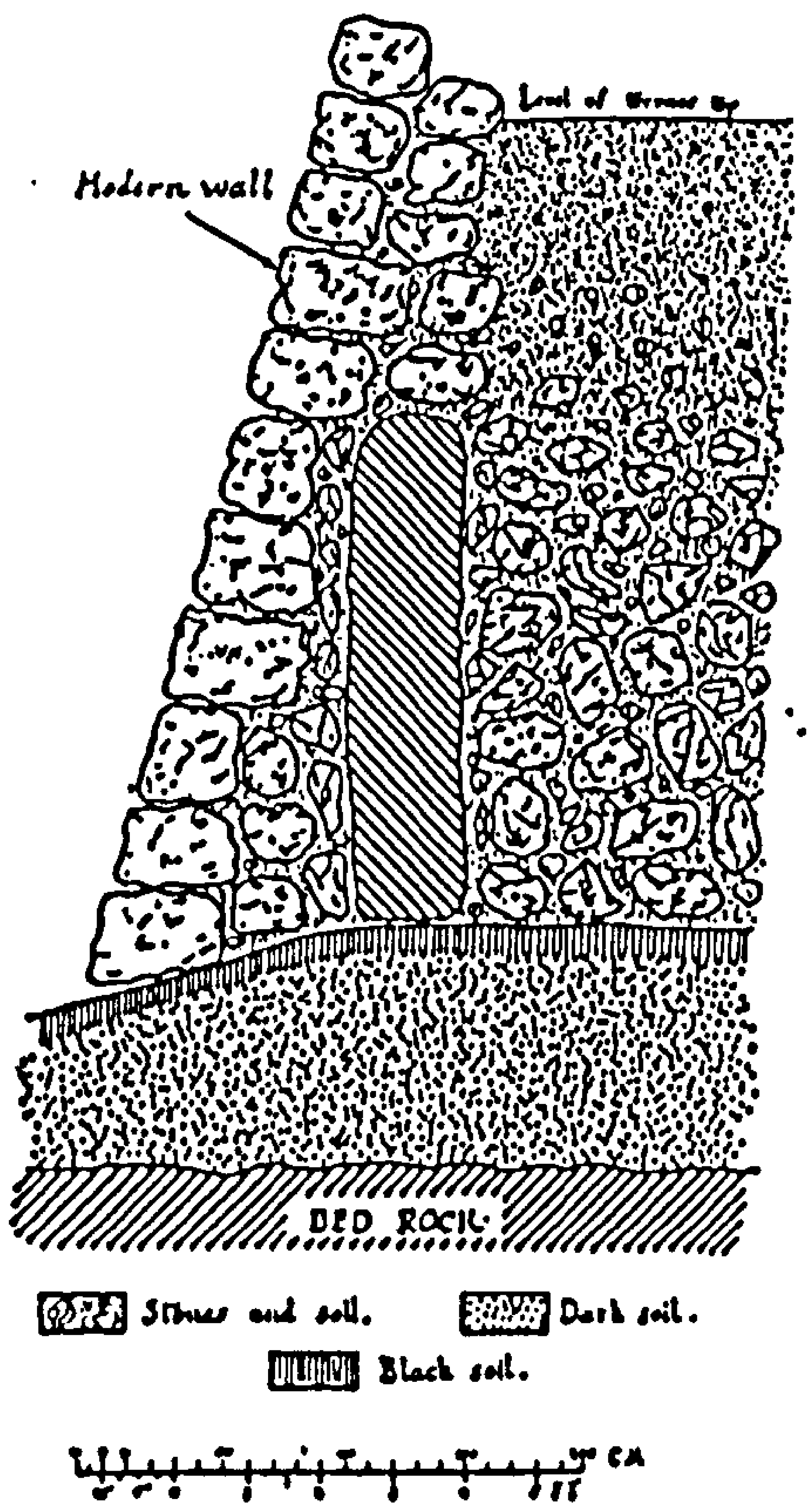


Fig. 4.39 Section of Ggantija Platform.

Probably the most likely sequence was that the builders of the South Temple allowed for an appropriate terrace in front of their temple (bounded by B-B-B Fig. 4.38) on ground sloping slightly downwards, and that the subsequent builders of the North Temple, had a similar more-or-less level area in front of their temple (B-B-C on the plan). The builders of the earlier South Temple would not have been likely, given the need for a frontal terrace, to have constructed their temple in such a position as to require massive revetment.

At some much later date in the Tarxien period, a bigger terrace was required. This is when it was extended to the extent of A-A-A on the plan, requiring megalithic walling shown in Evans' section and illustrated in Brocktorff's painting (Figs. 4.40 and 4.41):

Fig. 4.40 Ggantija Façade (Brocktorff)

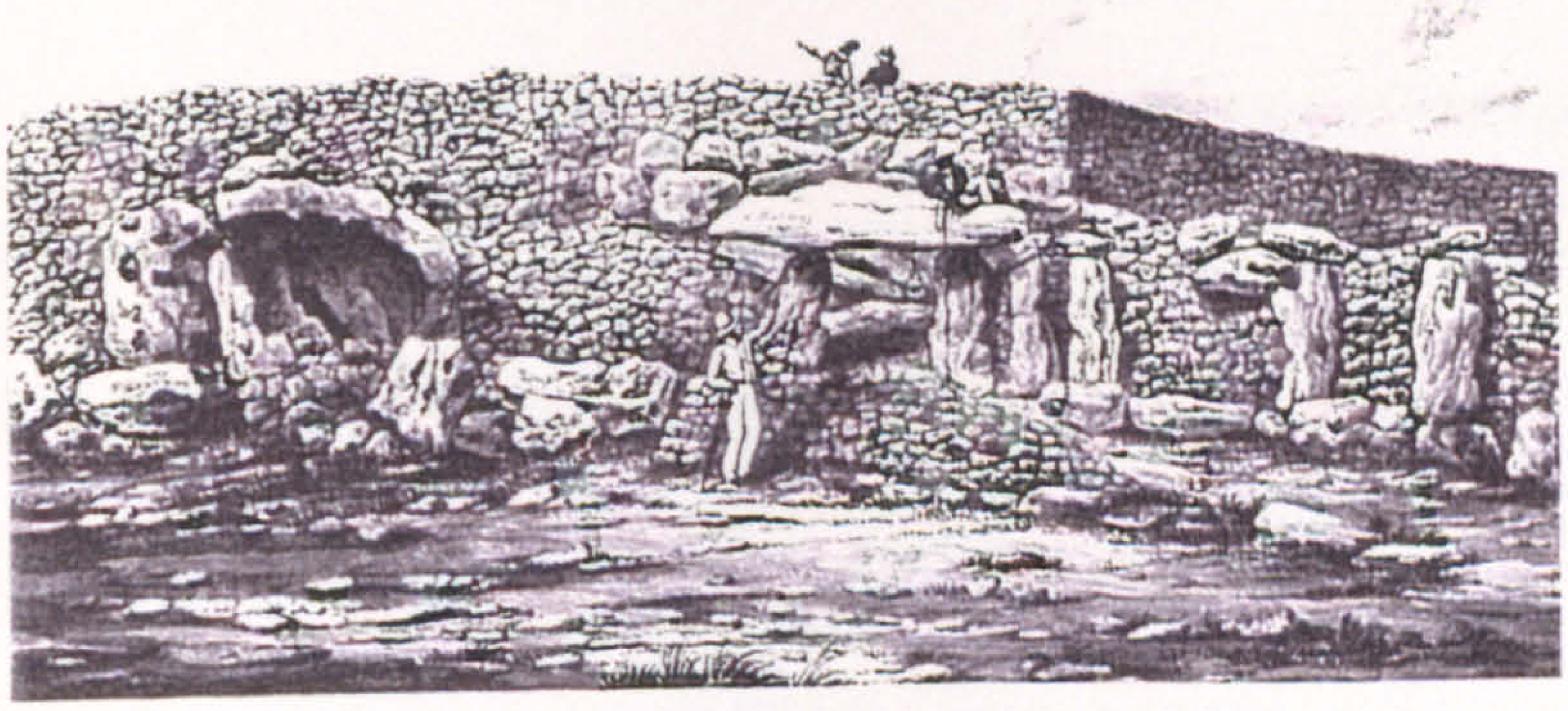


Fig. 4.41 Ggantija : Retaining wall of Platform (Brocktorff)

The plateau at Xaghra in the area of the temples, has an abrupt edge and we can reasonably assume that the retaining wall A-A-A on the plan was built relatively close to where the abruptness took place: say 7m. It is on these assumptions that I have calculated the following material requirements:

Original terrace for South Temple:

Infill : area 180sq m x 0.6m depth = 108cu m

Additional terrace area for North Temple:

Infill : area 120sq m x 0.6m depth = 72cu m

Tarxien period addition:

Megalith wall say 150sq m = 1059 tonnes*

Infill 18 x 75 + 7 x 75 x 0.6 = 1665cu m or 3330 tonnes

* Derived from data on the peripheral wall of the South Temple, see earlier.

4.14 CONCLUSION

The quantities given in this chapter have been carried forward to Chapter 6.

CHAPTER 5

MATERIALS: PROCUREMENT, TRANSPORTATION, PREPARATION & CONSTRUCTION

This chapter sets out to discuss the general principles underlying procurement and the particular sources relevant to Maltese temples. It then goes on to discuss methods of transport, and the transport routes used in relation to the Ggantija temple. Finally, methods of preparation and erection are covered. For each of these activities, the energetics involved are tabulated, in order that they may be applied to the quantities given in the previous chapter.

5.1 STONES

5.1:1 Location of Quarries, General

On the whole, prehistoric stone structures were built using the nearest source of conveniently useable stone, having due regard to the problems of transportation. One may cite Abrams (1987, 1989), Erasmus (1965), Sidrys (1978 a) for Mesoamerica, Schliemann (1875, 1880) for Greece and Turkey, Daniel (1958) for Wales, Hutton (1922) for Fiji, Renfrew (1979) for Scotland and Webster (1991) for Sardinia. Indeed, Trump (1990 b) suggests that in Sardinia, the siting of nuraghi was dictated by availability of suitable stones.

Sometimes, however, the structures were sited at places where large stones had to be transported considerable distances, e.g. on Easter Island where the huge statues mostly came from one volcanic crater (Heyerdahl 1958, 1961; Skjolsvold 1961). The most famous example is the bluestones at Stonehenge, Wilts. thought to come from the Preseli hills, in south west Wales, although whether they were entirely transported by man, or part transported as glacial erratics to the N. Marlborough downs, is still a matter of dispute. (Atkinson 1956, 1959; Thorpe & Williams-Thorpe 1991, Thorpe et. al 1991, Green 1997 and Scourse 1997). In any event very large stones were transported for considerable distances.

If water transport was available, distances from quarry to site might be increased, for this was an altogether easier way of transporting stone than overland. If Stonehenge bluestones were transported by man from Wales, waterborne transport would have been used extensively (Atkinson 1956, 1959). The Egyptians used the Nile extensively (Kemp 1989, Lehner 1985). The Minoans used waterborne transport from the Pelekita quarry to Zakros in Crete, where land transport was impossible (Shaw 1973).

At the same time, we should not forget that ritual requirements for location or prestige enhancement could be very powerful motivators, as indicated by the evidence of Easter Island.

How does Malta fit into this picture?

5.1:2 <u>Location of quarries on Malta</u>

In Malta the only reference to temple quarry sites appears to be in Ellul 1988 (4,5). Ellul comes from a long family line which has farmed around Hagar Qim, helped in the 1839 excavations and has acted as guardians at the site for generations, so he speaks from tradition and knowledge.

"Man ... started building himself ... a ... kind of house. This he did from the loose, flat slabs of rock found in the surface layer on the crest of hills. Now transport was his greatest difficulty. So, whenever possible, he would try to do without it. Most often, he would start to erect his building on the very same spot where he found his building slabs, which required only to be raised upright. But naturally he would require to dig up a comparatively larger area to build a temple that requires a large number of blocks.

"At Hagar Qim, the face of the rock where they had arrived unearthing the blocks of stone, is about a hundred metres to the S.E. of the ruins, in a field to the south of the gate. (Now it is levelled by modern bulldozers.) Another rock face could be seen about 200 metres to the South West on the way to Mnajdra. If one goes to the spot, one may see very clearly for oneself."

Joseph Ellul has some distinctly odd ideas, (for instance, that Hagar Qim was destroyed by the flood into the Mediterranean when the Gibraltar land bridge was breached 5000 years ago, the title of his book is "Malta's Prediluvian Culture"), that would not be accepted by many. Nevertheless, his description of stone procurement seems to be sound.

The area discussed by Ellul was chosen for a close examination, despite the main area of investigation being Ggantija on Gozo, because it is a much more open area and not built over, and hence more revealing from the point of view of quarry location and stone transportation.

The author walked the territory around Hagar Qim and Mnajdra, which is shown on the contour map (Fig 5.1) and in sections on the section map (Fig 5.2). Marked on the contour map are the locations of Figs 5.3 to 5.4.

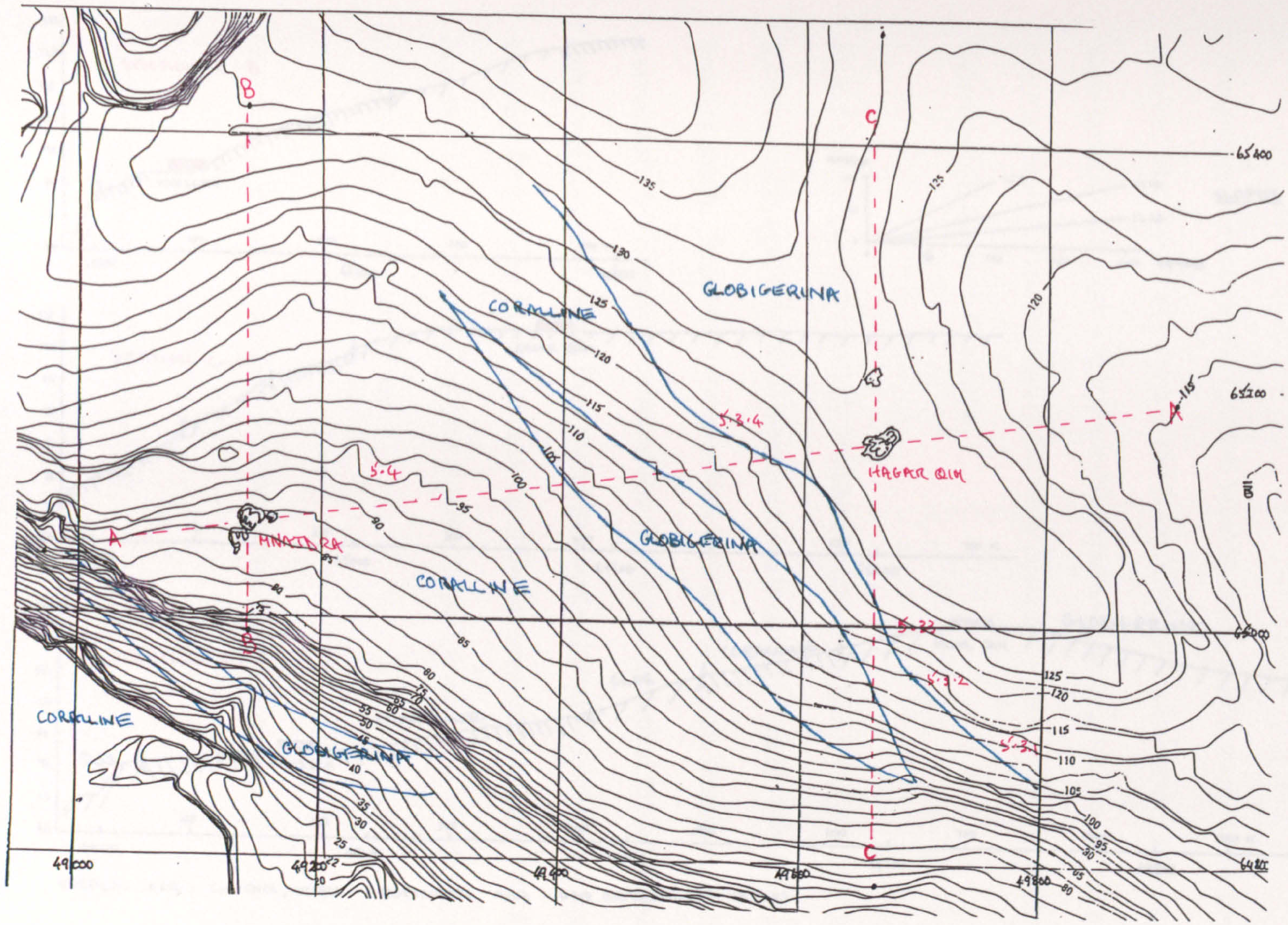


Fig. 5.1 Contour map : territory around Hagar Qim and Mnajdra. Scale 1 : 16,000

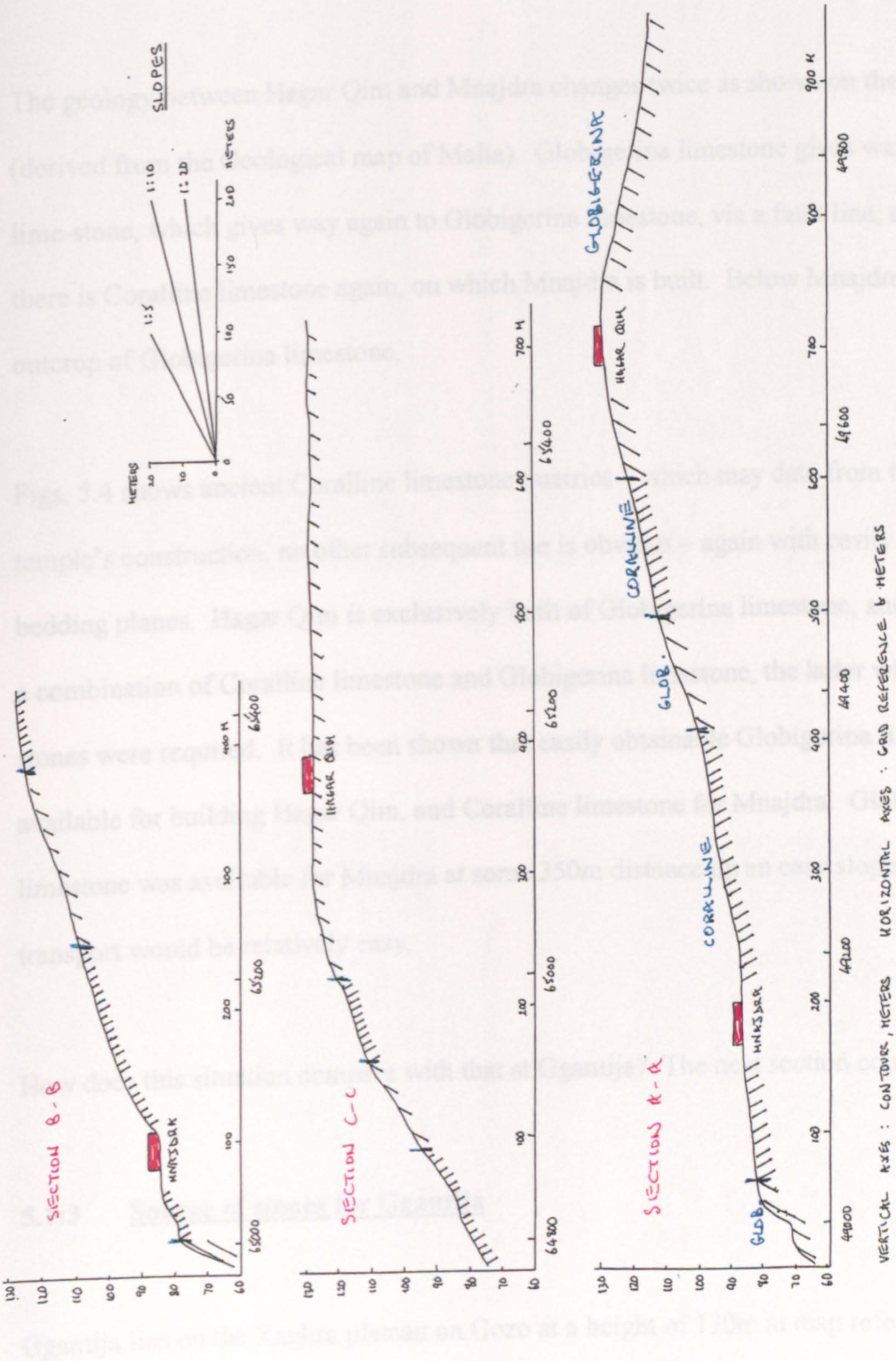


Fig. 5.2 Sections through Hagar Qim and Mnajdra territory

The plateau on which Hagar Qim is built, consists of Globigerina limestone. Fig 5.3 shows the availability of Globigerina limestone in weathered bedding planes and also the availability of plenty of smallish infill stones.

The geology between Hagar Qim and Mnajdra changes twice as shown on the contour map (derived from the Geological map of Malta). Globigerina limestone gives way to Coralline lime-stone, which gives way again to Globigerina limestone, via a fault line, and finally, there is Coralline limestone again, on which Mnajdra is built. Below Mnajdra is a further outcrop of Globigerina limestone.

Figs. 5.4 shows ancient Coralline limestone quarries – which may date from the Mnajdra temple's construction, no other subsequent use is obvious – again with easily useable bedding planes. Hagar Qim is exclusively built of Globigerina limestone, and Mnajdra of a combination of Coralline limestone and Globigerina limestone, the latter when dressed stones were required. It has been shown that easily obtainable Globigerina limestone was available for building Hagar Qim, and Coralline limestone for Mnajdra. Globigerina limestone was available for Mnajdra at some 350m distance up an easy slope, down which transport would be relatively easy.

How does this situation compare with that at Ggantija? The next section considers this.

5.1:3 Source of stones for Ggantija

Ggantija lies on the Xaghra plateau on Gozo at a height of 130m at map reference 342896.

The Xaghra plateau is upper Coralline limestone, surrounded by blue clay at a lower level, in turn surrounded by upper, middle and lower Globigerina limestone.

Globigerina limestone loose slabs

Globigerina limestone liftable bedding slabs

Plenty of small stones

Globigerina limestone bedding planes

Fig. 5.3 Stone availability Hagar Qim and Mnajdra

Ancient Coralline limestone quarry (a)

Ancient Coralline limestone quarry (b)

Ancient Coralline limestone quarry (c)

Another ancient Coralline limestone quarry

Fig. 5.4 Coralline limestone quarries near Mnajdra

Fig. 5.5 Geological map : Ggantija region
Greens : Upper Coralline limestone. Blue : Blue Clay. Yellow/Browns : Globigerina limestone ________ _ _ _ Faultlines. Scale 1 : 25,000

Fig. 5.6 Globigerina limestone outcrop on faultline

Fig. 5.7 View from outcrop to Ggantija looking north east

The geological map (Fig. 5.5) shows the configuration. Most of Ggantija is built of undressed blocks of Coralline limestone with occasional apparently dressed blocks. It is now difficult to see where this stone came from because of agriculture and urban development, but reference to the section on Hagar Qim and Mnajdra above, which lie in open country, would suggest that accessible and appropriate bedding planes of Coralline limestone would have been available at no great distance. The example of Mnajdra would suggest that suitable stone would have been available at 100-200m. Conservatively, we may assume 200m. To the north and west of Ggantija, the ground slopes gently upwards and there would have been no serious terrain problems presented to transportation.

Some parts of Ggantija are composed of Globigerina limestone, such as the entrance and interior jambs, presumably lintels, and carved temple architecture, such as the presumed "altars". Some of these blocks are over 2cu m (or around 4.5 tonnes).

Examination of the geological map (see Fig. 5.5) and walking the territory, reveals the nearest Globigerina limestone to be 600m distant in an east south east direction and 700m distant in a south south west direction. However, neither of these potential sources are outcrops and would have been difficult to utilise. In a roughly north east direction across the Ramla valley, is a Globigerina limestone outcrop at a height of 20m above sea level and 1.8km in a straight line from Ggantija, a distance that would be significantly increased by the need to traverse the sometimes steep slopes.

The most likely source is an outcrop on a fault line, with convenient bedding planes about 1.2km in a straight line in a south west direction on the outskirts of the modern village of Xewkija. See Fig. 5.5 and Figs. 5.6 and 5.7 for photographs. Map reference 335887.

A 1:2500 contour map, with contours at 2.5m intervals, allowed possible transport routes between this outcrop and Ggantija, to be plotted. Immediately to the south of Ggantija is a steep scarp sloping downwards, which would be the most difficult part of the route to negotiate.

Marked on an enlargement of the geological map (Fig 5.8) are the three routes which have been plotted on the contour map, (Fig 5.9).

Route 1 involves a maximum gradient of 10°. The total distance is 1200m, with 60m at 10°, 50m at 5° and the balance less than 2.5°.

Route 2 has a maximum gradient of 5°, a total distance of 1250m, of which 120m is at 5°.

Route 3 has a maximum gradient of 2.5°, a total distance of 1400m, of which 200m is at 2.5°.

Route 1 is little shorter than route 2 and seems unlikely. Route 2 would require significantly more manpower than route 3, over 120m of its length and for the purposes of the energetics analysis, route 3 has been assumed.

This assessment is of course predicated on the assumption that Temple Period land forms were the same as modern ones. This may be incorrect for two reasons:

1. Erosion and/or deposition may have taken place. It seems unlikely that these would have had a major effect on the routes, or the slopes postulated.

2. There may have been tectonic disturbances since Ggantija was constructed. The

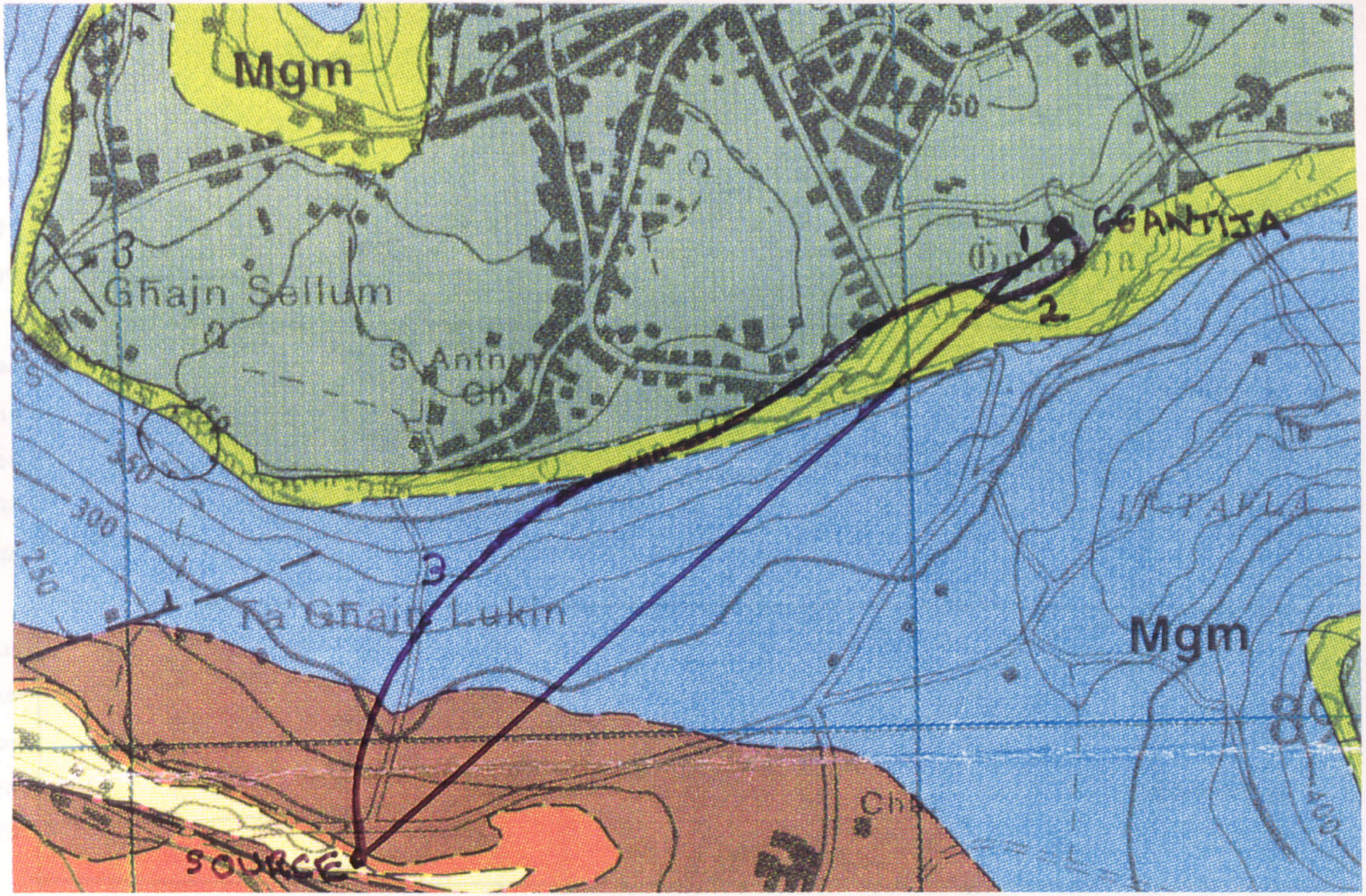


Fig. 5.8 Routes for Globigerina limestone transport to Ggantija

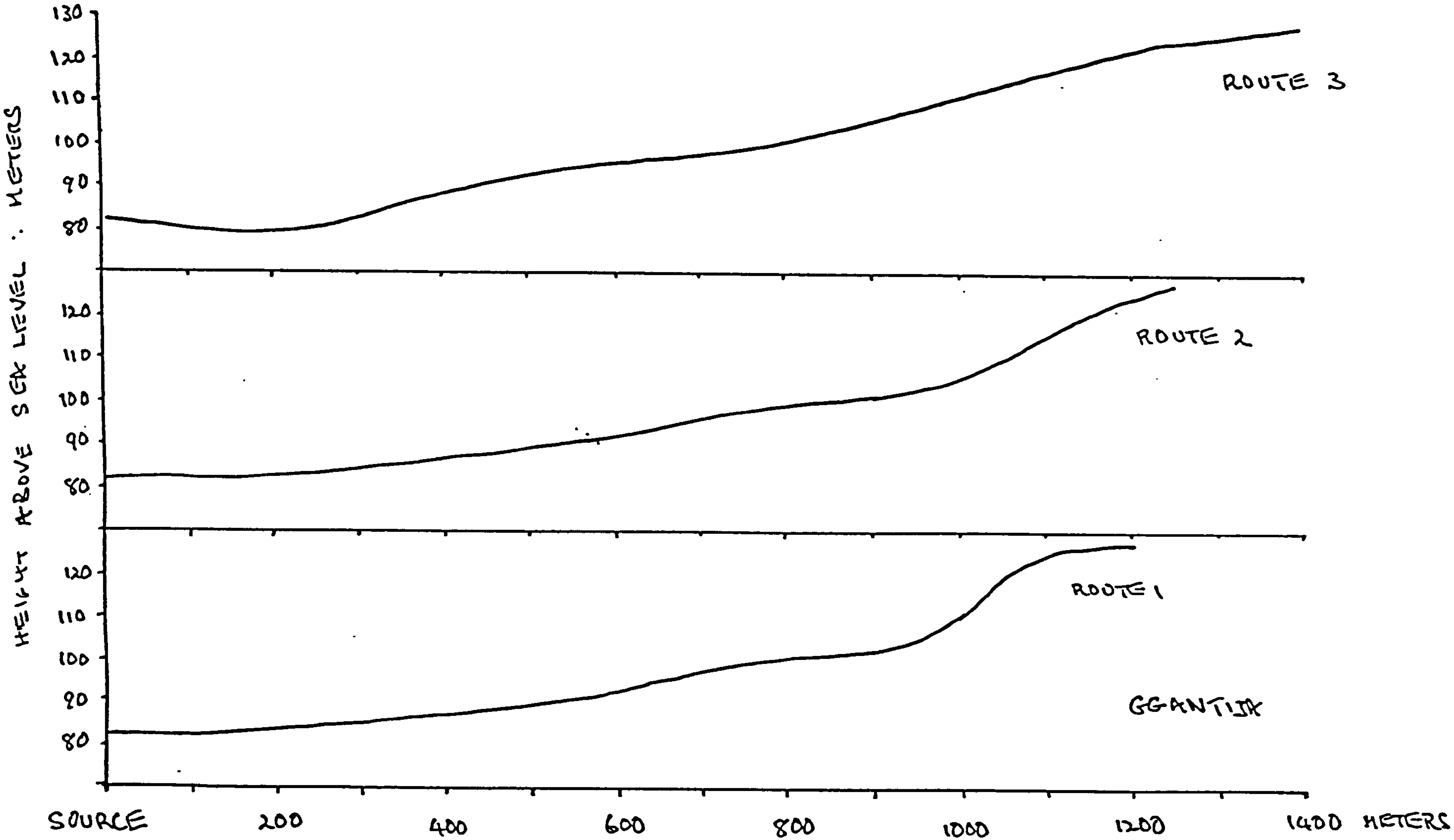


Fig. 5.9 Contour map: Globigerina limestone source to Ggantija

Maltese islands have been subject to such disturbances for millions of years : indeed they are the cause of Malta's complex geology, and of the many fault lines visible today. Zammit-Maempel (1977 : 18) suggests that some faulting may possibly have occurred since Neolithic times. Whether this applies to the Globigerina outcrop identified as the source for Ggantija, must be uncertain. It does not have the features cited by Zammit-Maempel as evidence for the recent origin of the Maghlaq fault on Malta. The possibility of post temple construction faulting proximate to Ggantija has therefore been ignored.

5.1:4 Methods of Quarrying

The literature has been reviewed for methods of quarrying and the energetics involved, that seem relevant to Malta. Additionally, two old time Gozitan quarrymen have been interviewed. This section presents the findings laid out by geographical location and concludes with a table proposing labour estimates for use in the energetics analysis. By way of preface to all the labour estimates, it is worth stressing the great variability of work rates – a point made by Ritchie (1976 : 51) in reference to Cornwall's (1974 : 199) experimental work at Wareham, Dorset.

The most useful experimental work has been done in Mesoamerica:

ABRAMS 1984 a (149-54 and 190), and 1989 (70), gives experimental data for quarrying tuff in lowland Maya country in Yucatan, Mexico. This tuff is consolidated small particle volcanic ejecta, and although of different origin, is similar in hardness and density to Maltese *Foraminifera*-based Globigerina limestone.

The quarrying technique he gives is to:

- Clear the outcrop of dirt and locate fissuring.
- Hammer spikes into the fissures (or specially cut "indentations"), lever about and break off the block.
- Cut the block into "suitably-sized" pieces. He does not say what these are, but one may assume 25-40kg.

Abrams cites various experiments and concludes that a reasonable average procurement rate is 750kg per person-day of 5 hours, using wooden and stone tools. This includes cutting into "suitably-sized" pieces, but not dressing.

ERASMUS 1965 : 285-6, writes about experiments he conducted in Yucatan, Mexico: "Had I not personally observed these experiments (on the excavation of building stones), I would not have believed that so much rock could be so rapidly pried from the surface of such a small area. A heavy hardwood post ... was used by a Mayan Indian ... skilled at excavating surface rock". He excavated 1700kg in five hours, a working day in the heat prevailing. This was one third the amount excavated by a man using an iron crow bar. The material was tuff and the block sizes ranged from 25-35kg.

SIDRYS 1978 b : 170, discusses the quarrying of limestone blocks for use as stelae in Mesoamerican Mayan sites. The method used was the common one of channelling sides and back "probably using imported greenstone celts and/or local large chert bifaces as chisels in conjunction with hammerstone or wooden mallets". The bottom was undercut at various points and levers placed in these, to snap the remaining "pegs". No labour estimates are given.

For Egypt, HODGES 1970 : 86-7, describes how "each block of stone appears to have been cut clear at either side and at the back by making a narrow draught, using either copper chisels and mallet or hand-held picks made of diorite. Along … the lower edge of the block, a series of pits were then cut and into these were driven wooden wedges, causing the block to split away from the parent rock. … the same method of quarrying is still used in many parts of the world". He gives no labour estimates, but illustrates his evidence with one instructive photograph (Fig. 5.10)

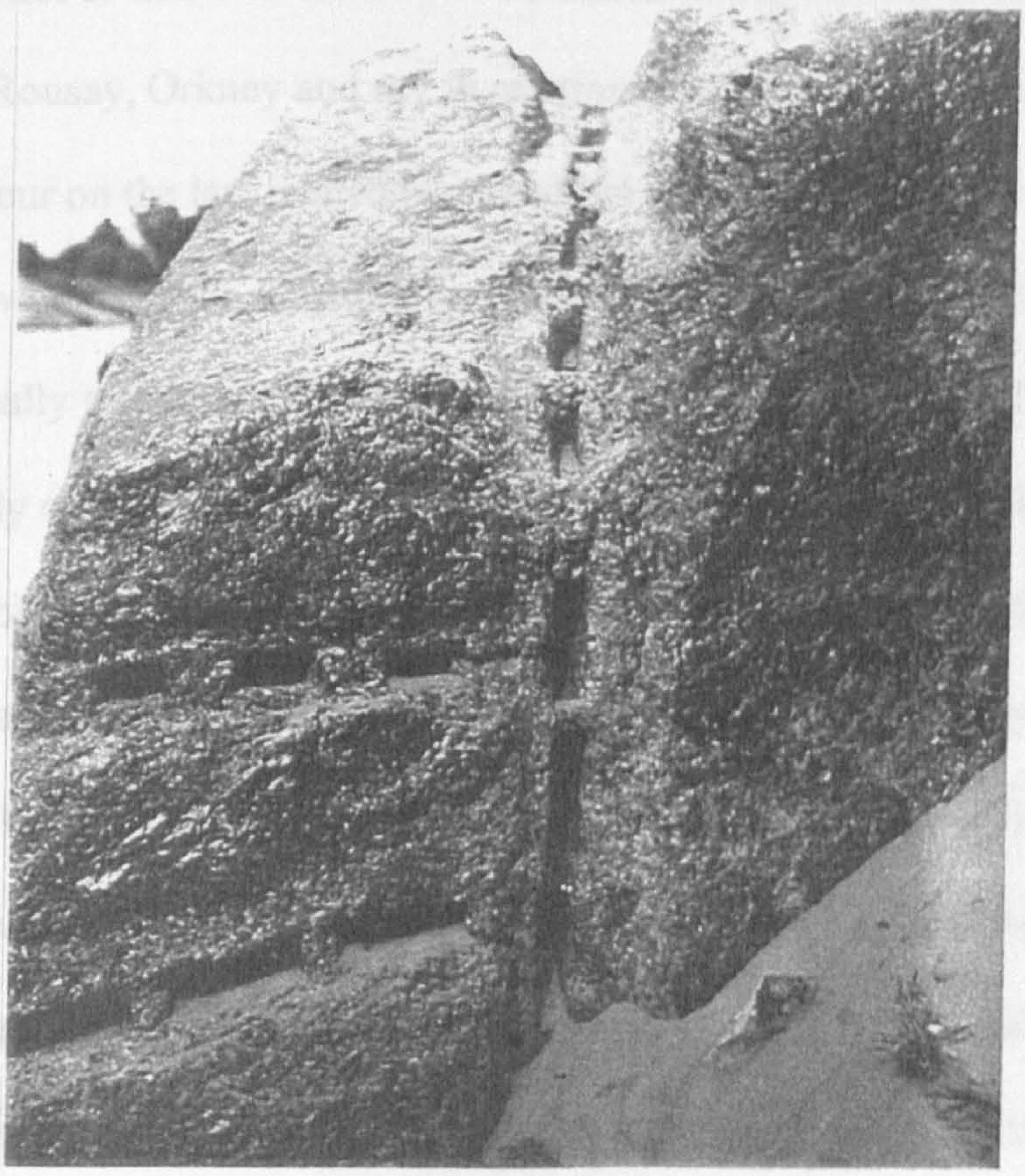


Fig 5.10 Quarrying wedge slots: Aswan, Egypt.

In <u>Britain</u> RENFREW 1979 a : 212-3, uses information from an anonymous retired country builder for data on Neolithic Orkney, as follows:

Quarrying limestone 4 tons per 8-hour day. Quarrying granite, output would drop to one third, to two thirds of a ton per man- day. These figures are for using metal tools and Renfrew suggests halving them for Neolithic equipment. This would equate to 1250KG per five-hour day.

RALSTON 1976, discussing the Stones of Stenness, Orkney, suggests figures given by CLIFFORD 1950 are relevant to Stenness. Clifford's data were that the fine grained sedimentary limestone, oolite, used at Rodmarton, Gloucestershire, might be extracted at the rate of 500kg per man day.

CALLANDER & GRANT 1934 : 444-5, discuss the quarrying of rock for the Broch of Midhowe, Rousay, Orkney and say in relation to broch construction generally "Six [brochs] occur on the last-named island within a distance of 4 miles as the crow flies, and within a few yards of the flagstone rocks of the Old Red Sandstone formation, which fall down gradually to the water's edge in a series of ledges and steps. These rocks provided a handy supply of good building material, as many slabs had been dislodged by natural causes and others could be levered or wedged off without much difficulty. We have been informed that wedges of wood, driven in dry and allowed to swell by the absorption of sea-water, have been used within living memory in Orkney, to prise off slabs. The stones also break with a natural fracture, often leaving three straight edges, some at right angles to each other, and to the bedding plane. In the neighbourhood of Midhowe and other brochs on Eynhallow Sound, it is quite plainly seen where slabs had been skinned off to furnish the stones to build them". No labour estimates are given.

ASHBEE & CORNWALL 1961 : 131-2, describe "digging" chalk. In passing, they note the efficiency of using the brow, tine and beam of a Wapiti antler to lever out a 1-2cwt sarson stone. Digging a ditch in chalk, including bucketing it out, resulted in 5cu ft/man hour. Doubling this for digging only, and otherwise using Ashbee and Cornwall's data gives a figure of 0.44cu m (or approximately 1 tonne) per man day of 8 hours.

For <u>Sardinia</u> CAVANAGH & LAXTON, 1987 b : 41, say concerning Sardinian nuraghi:

- For Bronze Age quarries (where metal might have been used) "the quarrying of stone may have been so informal as to leave no clear trace".

- "rubble would probably have been fragmented ... by ... undercutting and fire-setting."
- "for large, more regular blocks ... it is possible that more sophisticated methods using channels, drilled holes, cuts and wedges were used."
- It seems – "probable that natural bedding planes were exploited to give stones of approximately equal size."

WEBSTER, 1991, in relation to nuraghi construction, makes some detailed calculations of the labour input to their construction. On page 845, he says large stones at the base may be 1cu m weighing 2250kg, smaller higher ones 50 x 50 x 25cms, weighing 140kg, with an average of 75 x 50 x 50cms, ie. 0.2cu m weighing 450kg.

On page 848, he suggests that "building stone was procured from shallow bedrock deposits at no great distance. The weathering of shallow surface bedrock [basalt in this case] is, in many elevated locations, visibly advanced. Today [fields are] densely strewn with nuraghi-sized boulders". Further "one might guess that simple wood and stone tools would have served – wooden prey-bars and splitting wedges, hard stone hammers". Evidence "... suggests distances of less than 200m." (with 2km a maximum).

On quarrying, transporting, rough dressing and wall construction, he uses data from Erasmus 1965 and Abrams 1984. These are noted above. But it is worth pointing out that Erasmus was reporting on the quarrying and transport of blocks, averaging 30kgs in weight, well below any reported by Webster.

On <u>Easter Island</u>, HEYERDAHL, 1958 and SKJOLSVOLD, 1961 : 365-374, describe how the mayor and five of his men, picked up abandoned stone picks at the quarry site of Rano Raraku. Clenched like daggers in their hands, they used them to cut side and back grooves for a potential statue, using copious water. The stone is hard volcanic and this was essentially a bashing, not a cutting technique, accompanied the while by rhythmic chanting. Time estimates were that two teams of six, working shifts, would require 12 months to cut a block about 5 x 1.5 x 1m. This estimate is very much larger than any given above. The stone is harder, the work was not taken to a conclusion and it may be that there was a certain predisposition by the modern Easter Islanders (and perhaps the Norwegians) to exaggerate the achievements of their ancestors. Nevertheless, if correct, the demand for surplus labour on Easter Island would have been huge and would have placed a real strain on society.

For Malta, POLLINI, 1988 : 136, gives the following figures for the three sizes of block he considers:

2.5 tonne blocks, 7-11 hours	=	0.7 tonnes/day
3.5 tonne blocks, 11-16 hours	=	0.8 tonnes/day
11 tonne blocks, 14-25 hours	=	0.4 tonnes/day

The smaller blocks are predominant, so Pollini's average is say 0.7 tonnes/day, which equals 1.4 P.Ds./tonne (for a five hour day).

Gozo. Personal field work by the author : In September 1995, Comino Azzopardi was interviewed. He runs, together with his son, grandson and great grandson, a family Globigerina limestone quarry on the west of Gozo. Aged c.73, he lives in Xaghra. The huge quarry, now mechanised, used to be worked by him and his colleagues by hand, a process he described to me. Blocks 15' wide by 10' high by 4' deep (4.5m x 3.0m x 1.2m) were extracted by cutting channels at the sides and back, using a pickaxe. (See Fig. 5.10, Azzopardi was wearing sandals, had a sore foot, and it was very, very wet, so he didn't want to go into the quarry to demonstrate!) Slots were then cut in the base. Into these, metal wedges were driven (see Fig. 5.11) which then, or overnight, split off the block.

These large blocks were then cut by a similar splitting technique into building blocks 2'6" x 1' x 1' (0.8m X 0.3m) weighing c.153kg. (He may have exaggerated here: modern blocks average 1'10" x 10" x 9" (0.6m X 0.3m x 0.2m) weighing c.70kg and therefore moveable by one man.)

All this took two men, two days for 16cu m which equals c.4cu m per man day. It was luck whether splitting took place rectilinearly or not.

Fig . 5.11 Azzopardi demonstrating slot cutting

Secondly, Zerri Carmeno was interviewed. Formerly of the Gozo Museum Service at Ggantija, he was, before that, a quarryman.

He said the initial block size that would have been extracted was 30' x 12' x 5' (9.1m x 3.6m x 1.5m) which seems very large, maybe an exaggeration but he stood by his figures. He described the method of splitting the large blocks into building blocks.

V shaped wedges were cut, lined with steel bars and these were then riven by driving in steel wedges. See diagram below: His time estimates were similar to Azzopardi's.

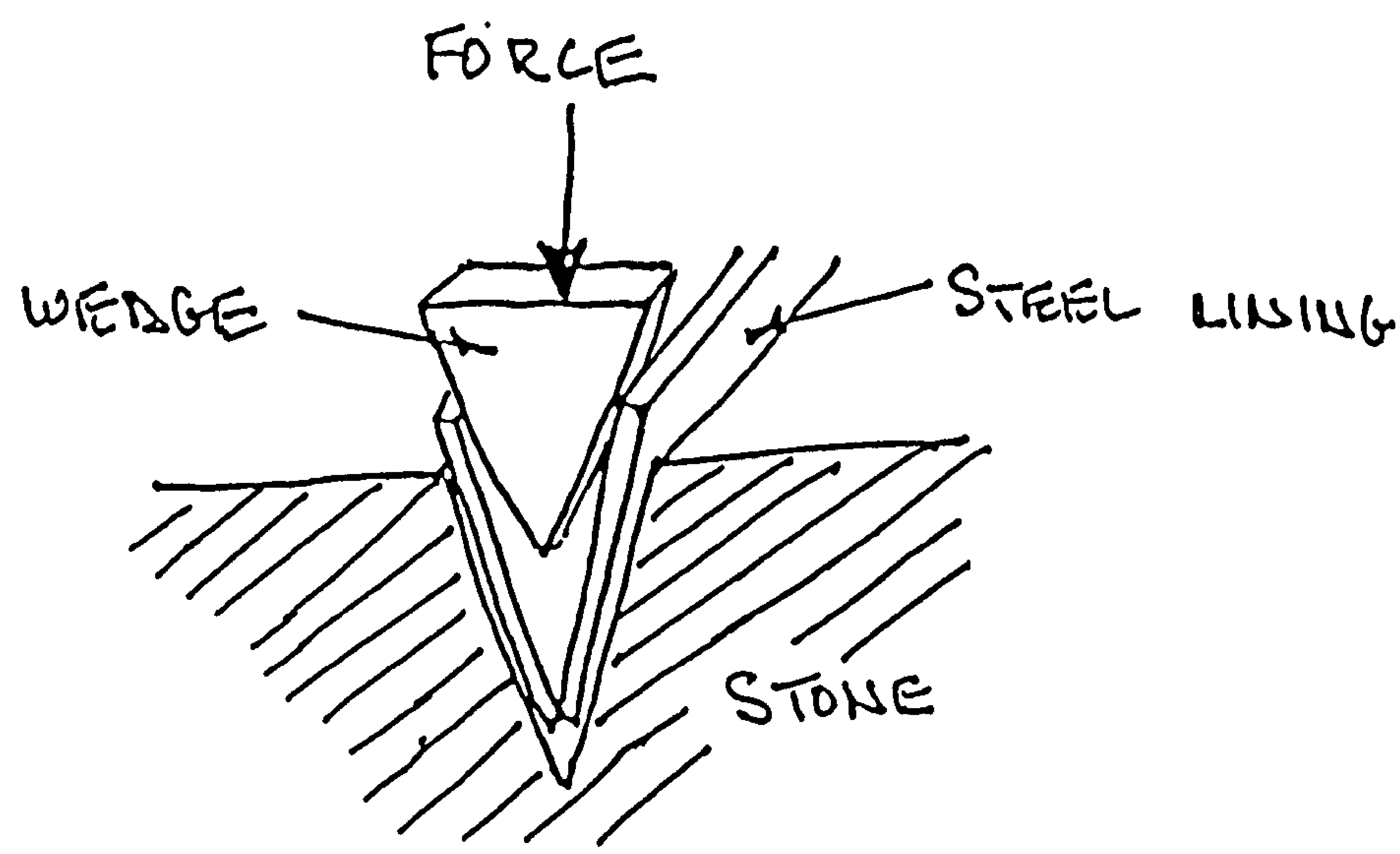


Fig. 5.12 Driving in splitting wedges

Dressing of these stones, and Globigerina limestone is very soft when first cut, was done with what Carmeno described as an axe, but I think was an adze: certainly dressing marks on old buildings appear adze-like.

All these techniques could be used using Neolithic equipment. Probably time scales should be doubled, see eg. Abrams 1984 a, whose experimental results using both stone and steel tools, showed a ratio of only 1:1.5, and Erasmus 1965, whose experiments showed a ratio of 1:3.

Drawing this data together, we can tabulate the following, using Neolithic methods:

Fig. 5.13 A relatively modern block split by wedging. Hagar Qim.

Fig. 5.14 Zerri Carmeno showing an unused splitting slot at Ggantija North Temple.

Type of Rock	Size of Block	Weight of Block	Person Days/cu m
Tuff Limestone (Yucatan, Mexico, Abrams 1989)	Various for building		2.93
Tuff Limestone (Yucatan, Mexico, Erasmus 1965)	0.01-0.02cu m	23-34kg	1.25
Hard Volcanic (Easter Island, Skjolsvold 1961)	7.5cu m	19 tonnes	480
Soft Limestone (Scotland, Renfrew, 1979 a)	Various for building		1.25
Granite (Scotland, Renfrew, 1979 a)	Various for building		10.0
Oolite (England, Clifford 1950)	Various for building		10.0
Chalk (England, Ashbee & Cornwall 1961)	Digging a ditch in chalk		0.44
Limestone (unspecified) (Malta, Pollini, 1988)	c.1.4cu m	3 tonnes	1.4
Globigerina limestone (Gozo, Author, 1995)	c.0.05cu m	c.120kg	0.5

On this showing the quarrying time for Globigerina limestone seems low: on the other hand, it is a very amenable material, so perhaps the figure might be accepted. (See end of this section for figure used in subsequent analysis.)

The data may be represented graphically:

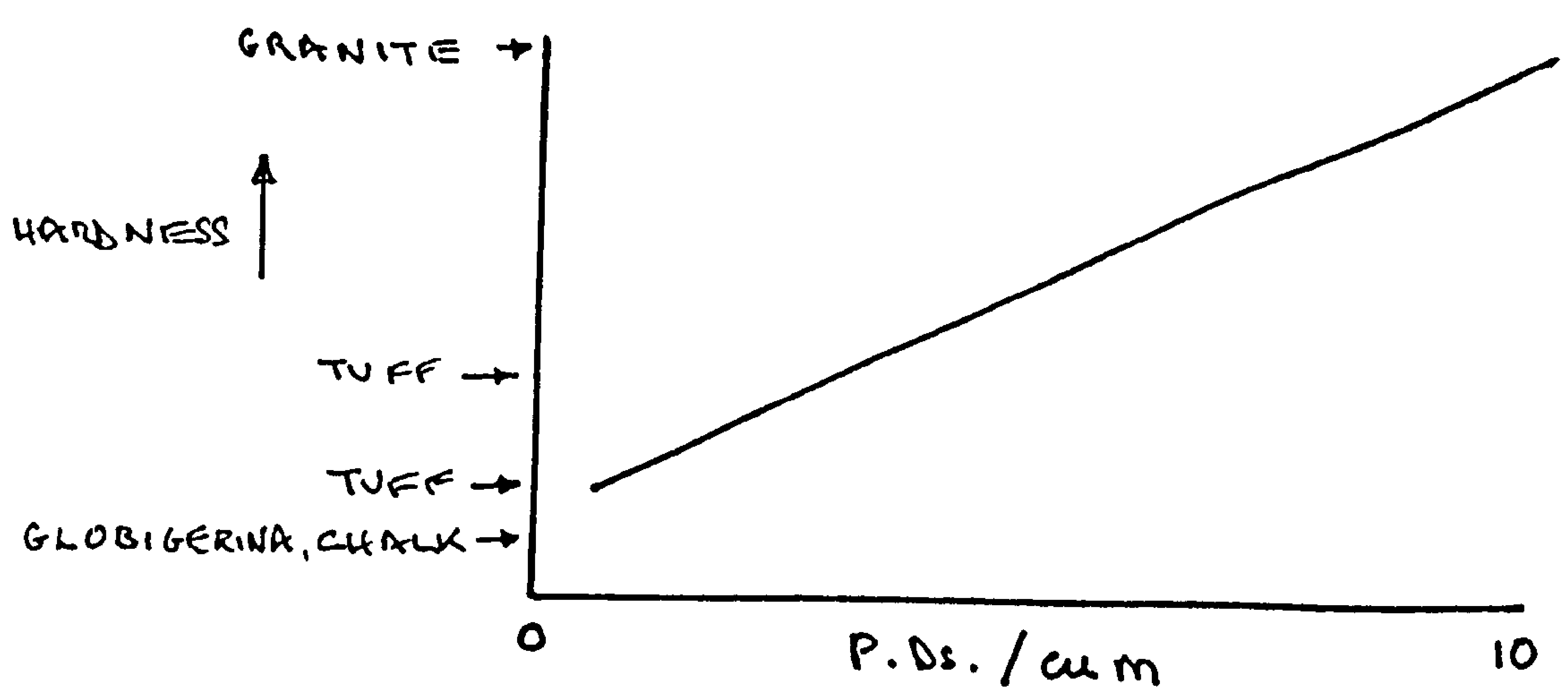


Fig. 5.15 Quarrying time : hardness v. labour

From the foregoing on the location of quarries and the method of quarrying, the following points may be summarised:

- Soft Globigerina limestone may be levered out of fissured courses.
- Available Neolithic techniques would allow the extraction and dressing of rectilinear blocks, using the side and back channelling method and freeing the block by baseline hole or partial channelling and breaking the block free by driving in wooden wedges, possibly including wetting them to cause swelling.
- Hard Coralline limestone blocks could be levered out from layered courses.
- Coralline limestone blocks could also be extracted as blocks, using the same quarrying technique as for Globigerina limestone, but this would be very laborious.
- A reasonable time estimate for sizeable stones, based on the above data, would be a minimum of 0.5 man days per cubic metre and a maximum of perhaps 2.9 man days per cu m, say an average of 1.0 man days per cu m, whether for Globigerina limestone (involving some quarrying) or for Coralline limestone (assuming only levering out layered blocks), which at 2.2 tonnes/cu m = 0.45 P.Ds./tonne – and for rubble and earth, double this amount ie.0.23 P.Ds./tonne.

These figures of 0.45 P.Ds./tonne and 0.23 P.Ds./tonne, are the "central" ones, ie. the author's best estimates that are used in the energetics analysis in Chapter 6. The possible variations used in the Sensitivity Analysis, also in Chapter 6, are discussed. there.

5.1:5 <u>Methods of Stone Transport : General Description</u>

Wheels had not been invented when the Maltese were building their temples. Given this fact, the following transportation methods were open to them (always assuming that timber was available – a question addressed in Chapter 5).

The simplest method is to lift and carry.

This might be done by one man (carrying 20-35kg on his outward journey and returning empty throughout the working day), or two men, or indeed any number, up to about 36, who could have lifted and carried up to 2 tonnes using poles under the rock, suspended perhaps on shoulder harness, or with the rock tied to poles above it. See Figs. 5.16, 5.17, and 5.18.

Fig. 5.16 A Mayan Indian putting down a load, carried by tumpline. Modern sculpture belonging to author.

Above about 2 tonnes, carrying becomes impractical and resort must be had to moving the stone along the ground. Here, there are basically two methods:

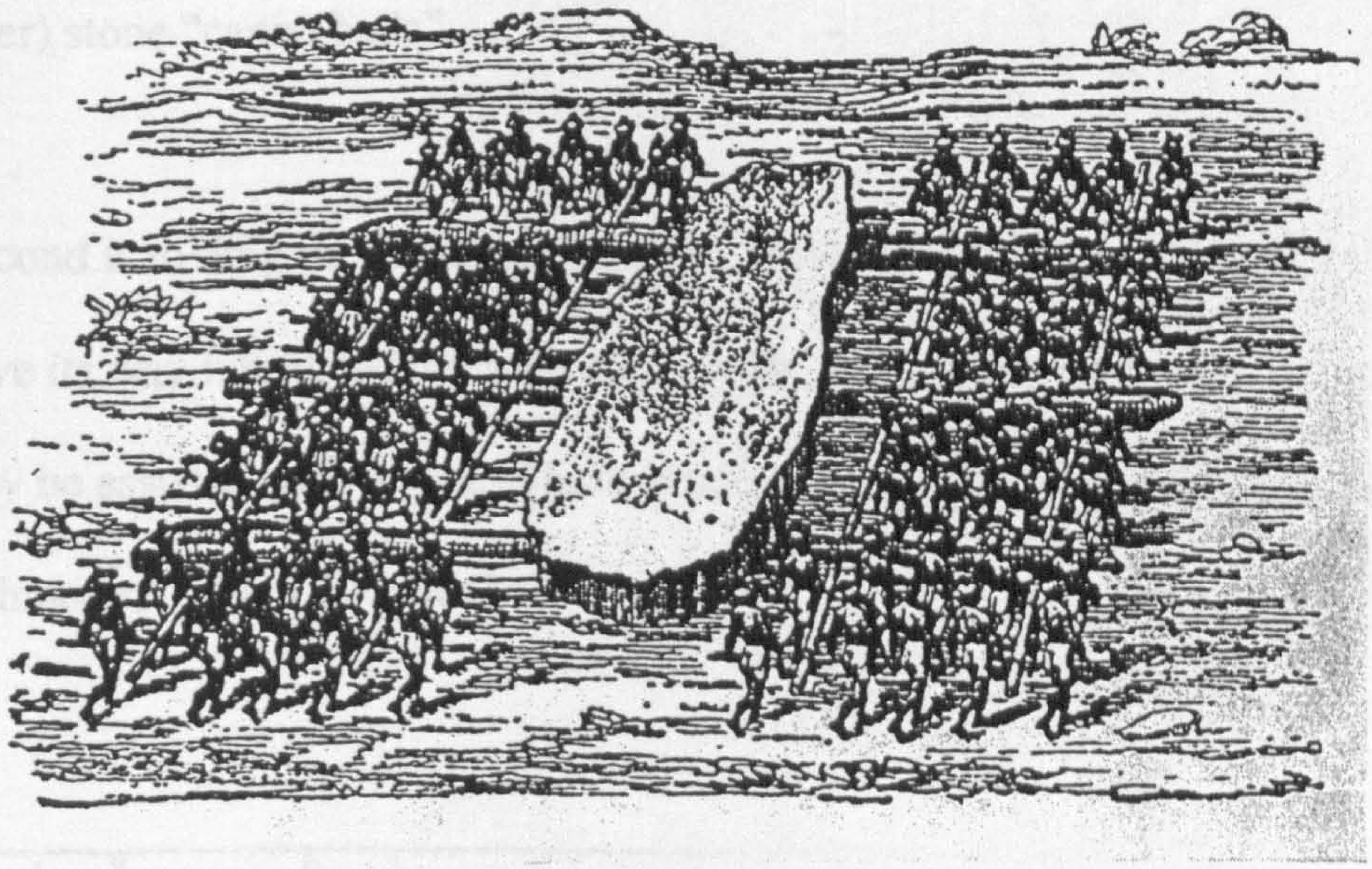


Fig. 5.17 Litter transport in the Himalayas

Fig. 5.18 Carrying a 1.5 ton stone column in La Venta, Mexico

1. The first is to employ levers, either on their own – they are a very efficient lifting device – or levers in combination with rollers or (perhaps relevant to Malta – see later) stone "canon balls".

2. Second is to drag the stone on a sledge. This may run over a specially made track, have its way lubricated with water or grease, or run on rollers. In any case, its passage may be assisted with levers. There is a fine Assyrian relief employing most of these techniques: Fig. 5.19 below.

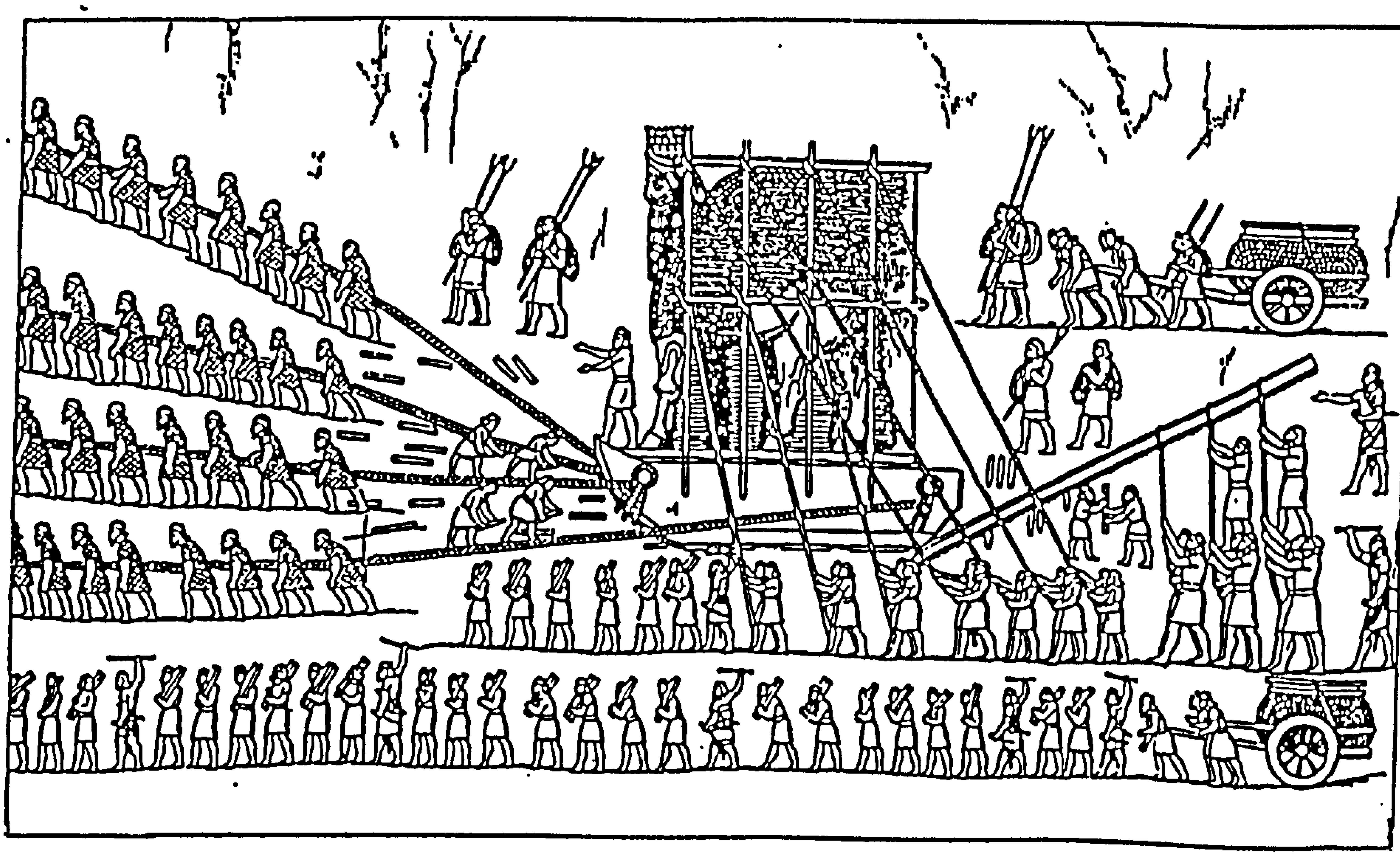


Fig. 5.19 Assyrian transport: eighth century BC.

Medium sized stones could be dragged along the ground on a V or Y shaped sledge, cut from a suitably shaped tree. Heyerdahl, 1961, reports an experiment using this method. Hutton, 1922, describes witnessing Naga tribesmen in Assam using such a method. See Fig. 5.22

Fig. 5.20 Tarxien Temples: 'Canon Balls' for transport?

Fig. 5.21 Tarxien Temples: Balls and cylinders for transport?

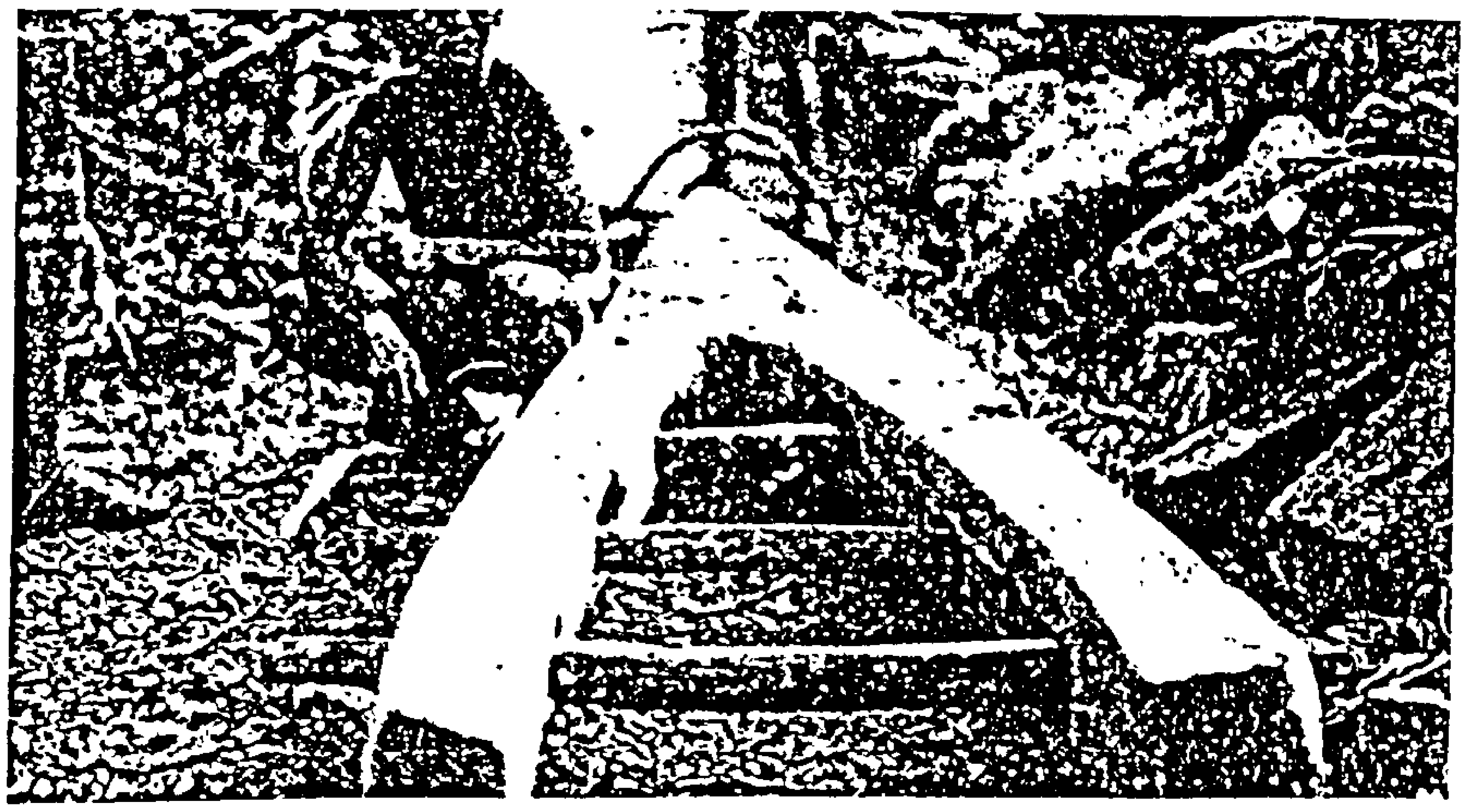


Fig. 5.22 Naga tribesmen using a V shaped sledge

5.1:6 Methods Of Stone Transport : Quantified Examples

There follows a review of the literature, especially where some indication of energetics is given. At the end of the section, the data have been tabulated.

ABRAMS 1984 a : 160 and 1989 : 70, gives the following formula for moving earth (derived from United Nations 1961, Economic Commission for Asia and the Far East 1957.) It is equally applicable to any load that can be carried:

$$\text{P.Ds./cu m} = \frac{L}{Q \times H} \times \left[\frac{1}{V} + \frac{1}{V^1}\right]$$

Where	P.Ds.	=	person days
	L	=	quarry to site distance in kms
	Q	=	quantity carried per journey in cu m
	H	=	hours per day (taken as 5)
	V	=	velocity loaded kms/hour (taken as 3)
	V^1	=	velocity unloaded kms/hour (taken as 5)

This works for any load one person can carry. If, for example, two persons are carrying one load between them, then the P.Ds. must be doubled.

ATKINSON, 1956 : 109, discusses the methods and energetics of moving the bluestones and sarsens of Stonehenge, Wiltshire. He suggests that wooden sledges were used, and describes an experiment where schoolboys, 32 in number, pulled such a sledge, weighing 3500 lbs (1500kg) up a 4° slope.

When rollers were placed under the sledge, the pulling numbers needed, reduced to 14, but of course the rollers needed moving too. In addition, steering ropes and people would be needed.

He goes on to suggest that 22 men per ton weight would progress at half a mile per day. "The heaviest stones, which weigh about 50 tons, would therefore need some 1100 men to move them."

ATKINSON, 1959 : 60-3, says that a 50 ton stone would require 100 men "to pull it along on rollers on flat ground, and at least another 100 to lay the rollers in front of the sledge and keep it from wandering sideways. To pull the stone up ... a gradient of 9° would need at least another 350 men".

If we take further figures from Atkinson, (1959 : 60) he says that with good rollers, 10 men could pull a 1.5 ton stone on a sledge up to a 4° slope: thus 7 men per ton. 50 tons would take 350 men. So his 450 men up a 9° slope, tallies better than his 1956 figure of 1100 men. All these figures need multiplying by 2.2 to convert from cu m to tonnes and we arrive at:-

$$\frac{350 \times 2..2}{50 \times 1.02 \times 0.5 \times 161} = 18.8 \text{ P.Ds. per tonne per km}$$

Newer work at Stonehenge has been reported by PAGE, (1996 : 27-31), and RICHARDS & WHITBY, (1997 : 235-39), concerning experiments made in 1994, in moving very large stones.

Using a wooden "railway", on which ran a wooden sledge with a 40 tonne replica stone strapped to it, they found that 130 people could move it with ease, downwards and on the level, and with difficulty up a 1:20 slope. To do this, required the use of modern grease to reduce friction. If tallow had been used, 200 people would have been required. Both the rails and the sledge were quite sophisticated in design, but within Neolithic capability. The sledge was pulled with ropes, which, by experiment, they found could have been sufficiently strong if made from plaited lime bast. If average speed = 1km per hour, for 5 hours:

$$\text{then P.Ds. per tonne per km} = \frac{200}{40} = 5$$

And if we assume track preparation and laying requires a like number of people per km per hour, we double this figure to 10.

COLES 1973 and 1979, gives various data on stone transport. An ancient Egyptian painting shows 90 men pulling a c.60 tonne statue on a sledge. A further 9 are involved in tasks like watering the path to reduce friction and using a lever to help over bumps. Thus, say 100 men for 60 tonnes or $\frac{100 \times 2.2}{60}$ = 3.7 men per cu m (on presumably level ground). (Coles 1973: 84.)

ERASMUS 1965 : 286-9, conducted experiments in the Yucatan, Mexico. His data are given below, Table 3:

Carriers	Total Trips	Total Distance (Kilometres)	Total Weight (Kilograms)	Weight Per Trip (Kilograms)
A 250 metres	34	17	950	28
B 500 metres	20	20	500	25
C 750 metres	15	22.5	517	34
D 1000 metres	11	22	250	23

Table 3 : Rock Carrying Experiment.

Carriers B, C and D used tumplines, A carried on his head. The average is 27kg over a total distance of carrying there, and coming back empty, of 21km per man day.

Although his narrative is a bit confused, he also gives a graph:-

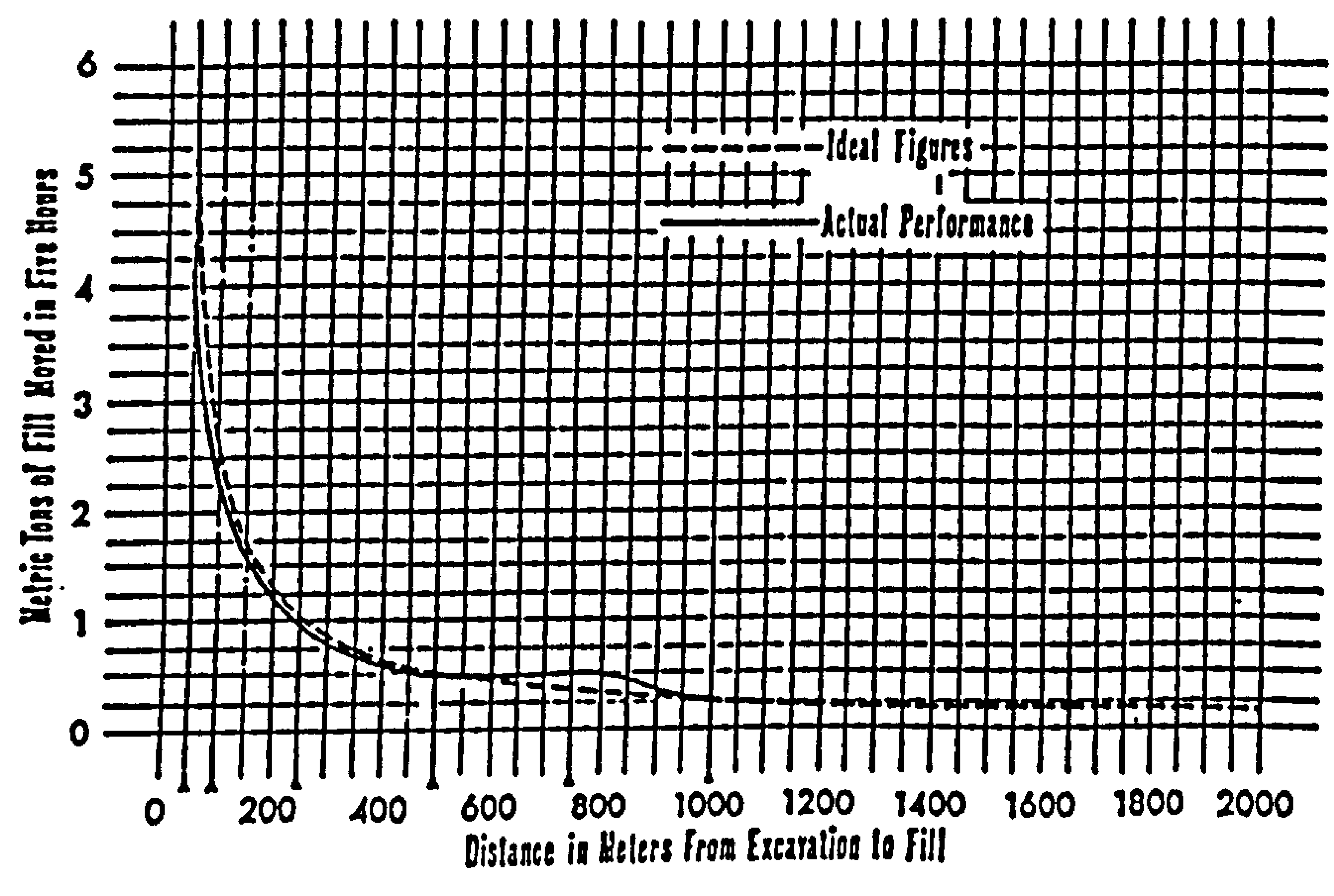


Fig. 5.23 Relation of load to distance for human carriers

As a cross-check, the author compared data from this graph with Abrams' formula (see above). From the graph for a distance of 0.5km, one person would carry 0.5 tonnes in a day. This may be converted to 4.4 P.Ds. per cu m. Using Abrams' formula, we get 4.8

P.Ds. per cu m, so there is remarkable correspondence.

HEIZER, (1966 : 825), describes an experiment in La Venta, Mexico, which showed that a stone column, weighing 2 tonnes, was the maximum that could be lifted, by 35 men, using rope slings and shoulder poles. If they progressed, on average, at 1km/hour for 5 hours, this equals 3.5 P.Ds./tonne/km.

HEYERDAHL, (1958 and 1961), and SKJOLSVOLD (1961 : 365-74), on Easter Island, organised a gang of 180 "previously feasted" men to pull a 4m. statue weighing 10 tonnes "some distance" on a Y shaped wooden sledge, without rollers, on level ground. This equates to 18 men per ton or 40 men per cu m. Speed was not given, nor were the consequences of feasting assessed!

HUTTON 1922 : (244-7), describes the transportation in 1921, of stone statues in Fiji, by Naga tribesmen. The sledge on which the statues were transported, was a V shaped main timber from a forked tree, with cross slats to carry the statues. The larger of two statues weighed perhaps 1.5 tonnes. The sledges were pulled by an unspecified number of men, but up to 200 were available, when necessary, using natural creeper ropes. The transport was accompanied by much ceremonial. It is fairly clear that the number of men available, was not the minimum required to pull the sledge, "the pullers for the [smaller] stone were few in number". See Fig. 5.22.

Reports of similar sledges have been made in other Asian and Pacific ethnographic investigations.

RENFREW, 1979 a : (213), gives some transport times given to him by an old time Orcadian builder:-

1000 cu yds of stone materials being carried over 50yds, would take 1000 man hours, which converted to metric units, equals 2.2 P.Ds./cu m/km. This is close to the result of 2.3 P.Ds./cu m/km, produced by Abrams' formula.

SIDRYS, 1978 b : (172), says that "in Sumba, for example, an 11 ton block was dragged on a sledge for 3km by 525 men in two days.

This means that $\frac{525 \times 2}{11 \times 3}$ = 32 P.Ds. per ton, per km were required equivalent to 69 P.Ds. per cu m, per km.

POLLINI, (1988 : 134-51), for Malta, divides transport labour into two: that required for moving quarried blocks from immediate quarry site, to a pre-constructed transport sledge track, and the labour required for moving the blocks along the track. He divides his blocks into: small (average 2.5 tonnes), medium (3.5 tonnes), and large (11.0 tonnes). For a five hour day, labour required ranges from 54 to 152 P.Ds./tonne/km and averages 70 P.Ds./tonne/km. It should be noted that Pollini assumes there are no blocks or rubble small enough to carry : all his material is moved by large block transport methods.

THE AUTHOR at Chongqing, China in 1997, at a drainage construction site, observed two men carrying a large stone slung from a pole over their shoulders. Based on the photograph, Fig. 5.24, the radius of the roughly spherical stone, was 23 cms, its volume 0.05cu m, and weight at 2.2sg, 0.11 tonnes. This is a heavy load and so if we assume they can carry it for 3.0 hours per day at 2km per hour, then P.Ds. per tonne per km = 4.5.

Fig. 5.24 Two Chinese carrying a stone

ZAMMIT, 1930, on Maltese temples says:-

P.10 "... the stone blocks of which [some temple structures] are made, rested on rows of spherical stones, varying in diameter from about one to two feet ... These stone balls are met with in all the Maltese megalithic ruins, and must have served the purpose of rollers".

P. 85 "Probably [the larger stone balls] served the purpose of rollers to help shifting of the large stone blocks. Being of soft Globigerina limestone, they were easily shaped, both intentionally and by dint of being rolled under the pressure of a heavy weight. They broke easily, and many fragments of them have been found. ... One cannot fail to conjecture, however, that they might have had a religious significance". Of these remarks Heizer, (1966 : 829), comments "The limestone balls of Malta are, however, clearly too soft to have been used in this fashion" without elaborating further. Heizer's scepticism would appear to be justified.

5.1:7 Tabulation of Results for Stone Transport

A. Liftable weights, small

Abrams' formula is:

$$\text{P.Ds./cu m} = \frac{L}{Q \times H} \times \left[\frac{1}{V} + \frac{1}{V^1}\right]$$

We can apply values to this formula:

L = distance to materials = say 1km

Q = capacity of container = say 0.014 (30kg at 220kg/cu m)

H = hours per day, taken as 5

V = speed in km/hour loaded, taken as 3

V^1 - speed in km/hour unloaded, taken as 5

$$\text{Thus P.Ds. per cu m per km} = \frac{1}{0.014 \times 5} \times \left(\frac{1}{3} + \frac{1}{5}\right)$$

$$= 7.6$$

or P.Ds. per tonne, per km = 3.5

Abrams' formula has been used for the "central" energetics analysis.

B. Liftable weights, large

Heizer's experiment produced a figure of 3.5 P.Ds./tonne/km.

Pollini gives an average of 70 P.Ds./tonne/km.

The author in China, P.Ds. per tonnne, per km = 4.5.

<u>Conclusion</u> : Mexico was a controlled experiment and Heizer's figure of 3.5 P.Ds./tonne/km, has been used as the "central" figure. (Equal, it may be noticed, to the figure for smaller weights given above.)

C. Unliftable (dragable weights)

Summarising the above:

Atkinson: 17 men per cu m gives:

18.9 P.Ds. per cu m, per km, up a 4°. Multiply by $\frac{4}{3}$ for a 9° slope. Using sledge and rollers. English experiment.

Coles: 3.7 men per cu m on level ground. 60 tonne load on sledge, no rollers, level ground, derived from Egyptian painting.

Heyerdahl & Skjolsvold: 40 men per cu m: modern experiment, Easter Island.

Sidrys: gives 115 men/cu m and 69 P.Ds. per cu m, per km: modern Sumba.

Page & Richards & Whitby: give data allowing us to assume about 10 P.Ds. per tonne per km.

Pollini: gives data that equate to 70 P.Ds./tonne/km.

Conclusion: use Atkinson: say 20 P.Ds. per cu m, per km with a

1.5 x uplift for slopes of 5°. That is:

P.Ds. per tonne, per km downhill or level	=	9.1
P.Ds. per tonne, per km up a 5° slope	=	13.6

If, as suggested earlier in this chapter, Globigerina limestone blocks over 2 tonnes were resourced where indicated and carried on route 3, then 1 tonne takes 9.1 x 1.2 + 13.6 x 0.3 = 13.6 P.Ds., and smaller blocks less than 2 tonnes take 3.5 x 1.4 = 4.9 P.Ds. per tonne.

In Summary

Small loads ≤ 30 kg P.Ds. per tonne, per km = 3.5

Medium loads 30kg –2 tonnes P.Ds. per tonne, per km. = 3.5

Large loads over 2 tonnes P.Ds. per tonne, per km

- downhill or level = 9.1
- up a 5°slope = 13.6

In applying these data to the quantities involved, it has been assumed that the blocks used were dressed where procured, that is that the finished blocks were transported and that the dressing chippings were transported separately, to be converted into torba on the temple site.

5.1:8 Preparation of Stones

ABRAMS, (1984 a : 163-5), and also Abrams (1984 b), reports on the experimental dressing of 14 masonry blocks by four masons, using Neolithic tools. The experiments took place in the Yucatan, Mexico and were on the local tuff, which has similar characteristics to Maltese Globigerina limestone. He found that it took 11.6 P.Ds. per cu m or 5 P.Ds. per tonne. These figures have been used for Globigerina limestone blocks. He also describes (1984 a : 168-71), experimental sculpturing of both simple and complex motifs. Appropriate to the Ggantija sculptured stone surfaces are his simple motifs. See Fig. 5.25 below:

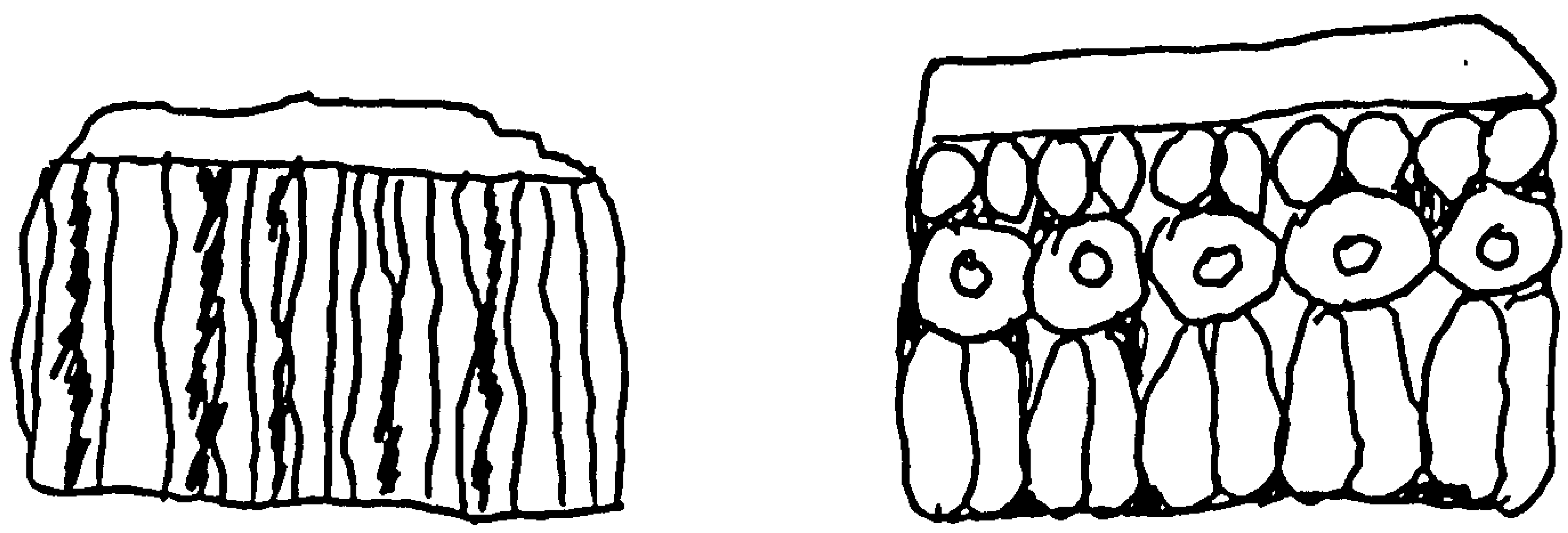


Fig. 5.25 Simple sculpture. Scale 1:6

The labour requirements based on 7 "simple" carvings, were 6.2 P.Ds. per sq m. These figures have been used.

Concerning Coralline limestone blocks, which constitute the vast majority of masonry in the Ggantija temples, it is presumed, based on their appearance, that no preparation was involved.

5.1:9 Erection of Stones

ABRAMS, (1984 b : 70), (see also Abrams, (1984 a : 175-6), gives a figure of 0.6 P.Ds. per tonne for dressed masonry walls, in Yucatan, Mexico.

ERASMUS, (1965: 291-2), gives a figure of 2.9 P.Ds. per tonne for cemented, dressed block construction, also in Mexico.

RENFREW, (1979 a : 212-4), quotes figures that work out at 0.2 P.Ds. per tonne for undressed blocks in Orkney.

A figure of 0.6 P.Ds. per tonne, has been used for masonry comprising blocks below 2 tonnes, that is those that can be carried by men.

For construction, using stones over 2 tonnes, other data are needed. These are scant because although many experiments have been carried out to erect large blocks, they have been concerned with how and by how many, and not with how long. Pollini (1988) has a complicated series of calculations to arrive at labour requirements for erection. He assumes all blocks are over 2 tonnes in weight and his data works out at an average of 5.1 P.Ds. per tonne.

RICHARDS & WHITBY, (1997 : 235-52), give figures from which one may deduce that 18,000 P.Ds. were required to raise seventy 40 tonne uprights at Stonehenge. This works out at 6 P.Ds./tonne. As they give no evidence for their numbers and this figure must therefore be somewhat conjectural.

It has been noted above, that the transport of large blocks over 2 tonnes, require 9.1 P.Ds./tonne/km over level ground, which compares with 3.5 P.Ds for stones under 2 tonnes, which may be lifted.

In the absence of any reliable person-day calculations for the erection of large blocks, the very arbitrary calculation has been used of applying the transport ratio for small blocks to large blocks (ie. 3.5 : 9.1) to their erection.

$\frac{9.1}{3.5} \times 0.6 = 1.5$ P.Ds./tonne for blocks over 2 tonnes.

5.2. <u>RUBBLE</u>

Very large quantities of rubble were used. The rubble comprised small stones, gravel and earth. The major quantity was used to infill the spaces between the outer perimeter wall and the apse walls. It was also used on the roof, the floor and on the terraces.

5.2:1 <u>Rubble Procurement</u>

It is assumed that the source was very local to the temples, averaging 0.2km and that procurement involved little more than digging it up. Abrams', (1989 : 70), formula gives a figure of 0.19 P.Ds./tonne and this figure has been increased by 20% to allow for the increased labour in prising out stones as well as earth, resulting in a figure of 0.23 P.Ds./tonne. (This may be compared with the figure of 0.55 P.Ds./tonne prising out chalk derived from the data in Ashbee & Cornwall, (1961 : 131-2), which involved significant quarrying from hard beds.)

5.2:2 Rubble Transport

Application of the standard formula (given for instance in Abrams, 1989 : 70), results in a figure of 0.7 P.Ds./tonne.

5.2:3 Rubble Erection

This is a very minor operation, basically tipping out the load, at times after carrying it up when infilling between walls, and some levelling. Abrams allows 0.1 P.Ds./tonne (1989 : 70) and this figure has been used.

5.3. TORBA

Torba is the plaster of prehistoric – and indeed later – Malta. It is made by grinding Globigerina limestone to a powder, mixing it with water and applying it in layers as one would the fired limestone plaster of today. As it dries, it becomes very durable, as witnessed by the remaining temple floors, which have been subjected to the elements over many centuries. It was used on temple floors, walls and, it is suggested, on temple roofs.

5.1:1 Procurement

Quarrying would have taken the same labour as Globigerina limestone blocks, ie. 0.45 P.Ds./tonne – see the preceding discussion.

5.3:2 Transport

Again, as Globigerina limestone blocks of less than 2 tonnes, i.e 4.9 P.Ds./tonne.

5.3:3 Preparation

This involved grinding pieces of Globigerina limestone to a powder. In the absence of more relevant data, a figure equal to Abrams' (1989 : 70) figure of 20 P.Ds./tonne for burnt lime plaster, has been allowed. This may be an over-estimate, but the labour involved was certainly considerable. (An experiment by the author involving bashing a small quantity of Globigerina limestone with a stone maul produced figures similar to those of Abrams.)

5.3:4 Application

Abrams, (1989 : 70), allows a figure of approximately 0.1 P.Ds./tonne for plastering. This figure has been used, except for roof plastering, where the figure has been doubled to allow for the problems of lifting to the roof and aligning the levels : in any event, the figure involved is small in relation to others.

5.4 TIMBER

5.4:1 Availability

In the previous chapter, it has been postulated that timber was used in the roofing of the Ggantija temples. In this chapter, the use of timber for stone procurement, transportation and erection, has also been assumed. It is now necessary to validate the availability of timber for such purposes. At the present time, there is very little standing timber on either

Malta or Gozo. There are stands of timber on lower-lying, fertile soils where agriculture has not encroached; typically, these are of Aleppo pine: *Pinus halapensis.* In addition, there are olive groves.

The amount of timber presently available would have been inadequate, certainly in the vicinity of the Ggantija temples. Present day evidence indicates that trees will grow, so the question is: to what extent did they, in the temple building period?

The evidence is conflicting.

STODDART and his co-authors, (1993 : 5), say "Available evidence from molluscs and pollen suggest a largely treeless landscape at a very early stage: timber was not as widely available as in other Neolithic societies." They do not quote the sources of their evidence. The author surmises that the mollusc evidence is from finds during the excavation of the Xaghra Stone Circle on the Xaghra plateau, close to Ggantija. This is a rocky, largely soiless area and the molluscs found there do indeed indicate treelessness and a preponderance of xeroresistant, open habitat, species. (Prof. Patrick Schembri, personal communication). This evidence does not of course preclude trees growing in more favourable conditions nearby. There is such an area immediately below and to the south of Ggantija, now given over to arable farming. There is no pollen evidence available from the Temple Building period, Malta, with its well draining, limey soils, is not conducive to its preservation.

TRUMP, (1966 : 51), footnote 5 reports the following: "A clay sample from a [Late Bronze Age] water Cistern near Luqa in 1960 was analysed for pollen by Professor H. Godwin of the Cambridge Botany School. Pollen was scanty, largely of Compositae, Plantago, and other arable weeds. *Pinus* was present but very scarce, *Olea* wild or cultivated also occurred." Thus by this date, c.1000 BC, it appears that vegetation on the island was much as today, largely treeless.

METCALFE, (1966 : Appendix V), reported on the botanical determination of charcoal samples found when Trump excavated the temple complex at Skorba, Malta. Earlier in date than the Ggantija Temple from the Ghar Dalam period, were Judas (*Cercis Siliquastrum*) and possible Hawthorn (*Crataegus* sp.) and Ash (*Fraxinus* sp.) and later in date Tarxien period, was Olive (*Olea europea*). This last came from the destruction level of the temple, and was presumed to come from the timberwork of the roof, with the implication that it came from well grown, domesticated olive trees.

The Skorba temple, like Ggantija, is built of Coralline limestone and the roofing is likely to have been similar. Thus, olive might well have been used (perhaps parsimoniously the prunings) for the lighter top layer to support a daub and torba overlay, but not for the longer span supports over the aisles. What was used for these, is not clear from Trump's report. TRUMP, (1966 : 51), "We know that timber, in large size and considerable, quantity, was employed in temple construction, and it is most unlikely all to have been imported for the purpose, from Sicily".

Although seaborne timber transport is well attested in the Bronze Age, there is negligible evidence for such transport in the preceding Neolithic/Copper ages, and it is unlikely to have been part of the Maltese Temple Period economy. Although timber could have been imported, if timber was available on Malta, there would have been no need to import, and this possibility has been ignored.

PATRICK SCHEMBRI informs the writer (personal communication), that he has charcoal evidence for Malta as follows:-

Ghar Dalam phase (5250-4550 BC)

Judas Tree

Hawthorn

Ash

Ggantija phase (3600-3000 BC)

Phillyrea (a member of the Oleaceae family and often mistaken for evergreen oak (Mabberley 1989))

Tarxien phase (3000-2500 BC)

Aleppo Pine

Olive

It seems that the conclusion should be that timber was available in the temple building period. This timber would have included both constructional timber – eg. Pine, Ash – and smaller species – eg. Olive, Judas tree and *Phillyrea*. It was probably available quite locally to Ggantija, in the fertile soils just to the south. One may assume that it could be obtained at an average of not more than 1km distance. The people of this time would have depended on timber, not only for temple construction purposes but also for fuel and for the construction of domestic residences. The latter may be assumed from the absence of any more than a very few archaeological remains of the use of stone for domestic purposes (eg. Malone and colleagues 1988).

One can imagine that the Neolithic/Copper Age pressure on timber resources, both from the need for timber and from clearance for agriculture, was quite intense, leading to the present eroded soil conditions and treelessness. Nevertheless, the conclusion above, that timber was available to the temple builders, stands.

5.4:2 Procurement

Using Neolithic equipment, Abrams, (1989 : 70), quotes the results of tree felling experiments in the Yucatan, Mexico: 13 minutes for a small tree and 88 minutes for a larger tree. These figures convert to 0.04 P.Ds. for a small tree and 0.29 for a larger one.

5.4:3 Transport

Larger trees 5m long, would weigh approximately 50kg ($5 \times \pi r^2 \times 0.5$ sg $= 5 \times \pi \times 0.08 \times 0.08 \times 0.5 = 50$). Two men could carry one of these at 2km/hour, which over 1km (the assumed distance) equates to 0.2 P.Ds. per tree, over 5 hours. Smaller trees, by a similar calculation, would weigh 2.5kg and would require 0.02 P.Ds. per tree.

5.4:4 Preparation

It is assumed that preparation ie. trimming, would require the same labour as felling.

5.4:5 Erection

It has been assumed that the same labour as for transport, is required, which may be over-generous, but the total figures are relatively small.

5.5 CONCLUSION

The figures given above are carried forward into the next chapter where labour requirements for the construction of the temples are calculated.

CHAPTER 6

ENERGETICS : THE LABOUR REQUIREMENTS

6.1 SUMMARY OF RESULTS

The results from Chapters 4 and 5, are presented below in tabular form. Separately for the South Temple, the North Temple (both of the Ggantija period, but built sequentially, it has been argued) and of the later Tarxien period extended terrace.

The total requirements, expressed in person-years, are given below. It is assumed that each person would work for ninety days per year, a figure discussed below. By way of explanation, 10 person-years, for example, might be provided by 10 persons working for 1 year, or 1 person for ten years.

For the South Temple	173 person-years
For the North Temple	74 person-years
For the "Tarxien" Terrace	91 person-years
Total	338 person-years

The chapter continues with a sensitivity analysis and concludes with a review of previous energetics analysis at Ggantija.

6.2 TABULATED DETAILS

These are given on the next three pages.

Total Labour Input To Ggantija South Temple

		Procurement		Transport		Preparation		Erection		
	Tonnes	P.Ds./ Tonne	P.Ds.	P.Ds./ Tonne	P.Ds.	P.Ds./ Tonne	P.Ds.	P.Ds./ Tonne	P.Ds.	Total P.Ds.
Masonry Walls (Coralline)										
Perimeter > 2 tonnes	691	0.45	311	3.6	2488	-		1.5	1037	
" < 2 tonnes	269	0.45	121	0.7	188	-		0.6	161	
Apses	637	0.45	287	0.7	446	-		0.6	382	
Over Portals	51	0.45	23	0.7	36	-		0.6	31	
Sub Total			742		3158				1611	5511
Rubble										
Between in/outer walls	4380	0.23	1007	0.7	3066	-		0.1	438	
Over portals	114	0.23	26	0.7	80	-		0.1	11	
Flooring	150	0.23	35	0.7	105	-		0.1	15	
Terrace	216	0.23	50	0.7	151	-		0.1	22	
Sub Total			1118		3402				486	5006
Pre Plastering Daub										
Apses	46	0.23	11	0.7	35	-		0.6	28	
Over portals	2	0.23	1	0.7	1	-		0.6	1	
Roof	75	0.23	17	0.7	53	-		0.6	45	
Sub Total			29		89				74	192
Torba (Globigerina)										
Apses	8	0.45	4	4.9	39	20	160	0.1	1	
Over portals										
Flooring	24	0.45	11	4.9	118	20	480	0.1	2	
Roof	38	0.45	17	4.9	186	20	760	0.2	8	
Sub Total			42		343		1400		11	1796
Globigerina Limestone										
Paving slabs	18	0.45	8	4.9	88	5	90	0.6	11	
Guttering	15	0.45	7	4.9	74	5	75	0.6	9	
Portal jambs > 2 tonnes	54	0.45	24	13.6	734	5	270	1.5	81	
" " < 2 tonnes	5	0.45	2	4.9	25	5	25	1.5	8	
Lintels > 2 tonnes	41	0.45	18	13.6	558	5	205	1.5	62	
Furnishings 16 sq m										
@ 0.78	2	0.45	1	13.6	27		12	1.5	3	
of which carved 3 @ 6.2							19			
Sub Total			60		1506		696		174	2436
Timber		Per Tree								
Large 384 Trees		0.29	111	0.2	77	0.29	111	0.2	77	
Small 3072 Trees		0.04	123	0.02	61	0.04	123	0.02	61	
Sub Total			234		138		234		138	744
Grand Total : P.Ds.			2225		8636		2330		2338	15529
Person Years Assuming 90 day year			25		96		26		26	173

Table 6.1

Total Labour Input To Ggantija North Temple

	Tonnes	Procurement P.Ds./ Tonne	Procurement P.Ds.	Transport P.Ds./ Tonne	Transport P.Ds.	Preparation P.Ds./ Tonne	Preparation P.Ds.	Erection P.Ds./ Tonne	Erection P.Ds.	Total P.Ds.
Masonry Walls (Coralline)										
Perimeter > 2 tonnes	199	0.45	90	3.6	716	-		1.5	299	
" < 2 tonnes	78	0.45	35	0.7	55	-		0.6	47	
" (reused)> 2 tonnes	143	-	-	-	-	-		2.0	286	
" " < 2 tonnes	56	-	-	-	-	-		0.8	45	
Apses	387	0.45	174	0.7	271	-		0.6	232	
Over Portals	51	0.45	23	0.7	36	-		0.6	31	
Sub Total			322		1078				940	2340
Rubble										
Inter walls new	138	0.23	32	0.7	97			0.1	14	
Inter walls reused	103	-	-	-	-			0.1	10	
Over portals	114	0.23	26	0.7	80			0.1	11	
Flooring	84	0.23	19	0.7	59			0.1	8	
Terrace	144	0.23	33	0.7	101			0.1	14	
Sub Total			110		337				57	504
Pre Plastering Daub										
Apses	27	0.23	6	0.7	19			0.6	16	
Over portals	2	0.23	1	0.7	2			0.6	1	
Roof	46	0.23	11	0.7	32			0.6	28	
Sub Total			18		53				45	116
Torba (Globigerina)										
Apses	5	0.45	2	4.9	25	20	100	0.1	1	
Over portals										
Flooring	14	0.45	6	4.9	69	20	280	0.1	1	
Roof	23	0.45	10	4.9	113	20	460	0.2	5	
Sub Total			18		207		840		7	1072
Globigerina Limestone										
Paving slabs	6	0.45	3	4.9	29	5	30	0.6	4	
Guttering	9	0.45	4	4.9	44	5	45	0.6	5	
Portal jambs > 2 tonnes	54	0.45	24	13.6	734	5	270	1.5	81	
" " < 2 tonnes	5	0.45	2	4.9	25	5	25	1.5	8	
Lintcls > 2 tonncs	41	0.45	18	13.6	558	5	205	1.5	62	
Sub Total			51		1390		575		160	2176
Timber	Number	P.Ds/ Tree		P.Ds/ Tree		P.Ds/ Tree		P.Ds/ Tree		
Large	234	0.29	68	0.2	47	0.29	68	0.2	47	
Small	1872	0.04	75	0.02	38	0.04	75	0.02	38	
Sub Total			143		85		143		85	456
Grand Total : P.Ds.			662		3150		1558		1294	6664
Person Years Assuming 90 day year			7		35		17			74

Table 6.2

Labour Input To The Construction Of The Ggantija Tarxien Period Additional Terrace

	Tonnes	Procurement P.Ds./ Tonne	Procurement P.Ds.	Transport P.Ds./ Tonne	Transport P.Ds.	Erection P.Ds./ Tonne	Erection P.Ds.	Total P.Ds.
Masonry Walls								
> 2 Tonnes	762	0.45	343	3.6	2,743	1.5	1,143)	) 4,749
< 2 Tonnes	297	0.45	134	0.7	208	0.6	178)	
Rubble Infill	3,330	0.23	766	0.7	2,331	0.1	333	3,430
Total P.Ds.			1,243		5,282		1,654	8,179
Total Person Years Assuming 90 Day Year								91

Table 6.3

6.3 SENSITIVITY ANALYSIS

There is a large number of assumptions in the energetics analyses, incorporated in the tables above. It is important to conduct a sensitivity check to assess reasonable upper and lower limits for this analysis. It is only fruitful to look at the major figures involved and an attempt has been made to do this in the following table.

The following aspects have been considered:

6.3:1 Original Heights

6.3:1a. The original height of the walls: the maximum height of the remaining perimeter wall is 7m. It has been assumed that it would not have been less and might have been 1m higher ie. 8m.

The remaining apse walls are much lower. That of apse 3, as marked on the plan, is 3m. However, if the theory advanced on roofing – ie. that there was a roof, and of what form – is correct, then the original apse walls must have been a minimum of 8m and, for sensitivity analysis purposes, perhaps 1m higher, ie. 9m.

6.3:1b. The same conclusions hold for the rubble infill, ie. assumed height 8m, maximum 9m.

6.3:1c. It has been assumed that the original heights of the North Temple were the same as those of the South Temple. The evidence for this is at the conjunction of the remaining North and South Temple walls, and the height of a portion of the north west section of the North Temple perimeter wall.

6.3:1d. There is no reason to vary the quantities given for the Tarxien period terrace, as this may reasonably be assumed to be the same size as originally built.

6.3:2 Procurement

The section on procurement in Chapter 5, shows enormous differences in the various estimates of labour costs involved. In the main energetics analysis, a figure of 0.45 P.Ds./tonne for stones of any size, has been used. It has been assumed that stone quarrying, whether of Coralline or Globigerina limestone, was from fissured, bedding-planed outcrops (the evidence for which has been covered in a previous chapter). If this assumption be allowed to stand, (ie. in particular, the cutting, splitting and levering out techniques discussed in Chapter 5 were not employed), a minimum figure of 0.23 and a maximum figure of 1.3 P.Ds./tonne seems reasonable, see Chapter 5. For rubble, ie. a mixture of stone and earth, a central figure of 0.2 P.Ds./tonne has been used, and there seems to be no reason significantly to alter this figure for sensitivity purposes. It derives from the detailed experiments described in Abrams (1984 a: 155).

6.3:3 Transport

There are two elements here: first the distance carried and second, the labour per kilometre involved. As far as the first element is concerned, the author is reasonably satisfied that the distances postulated (for Globigerina limestone, large Coralline limestone stones and smaller stones and rubble) are sufficiently accurate not to warrant a sensitivity variation. On the second, that of labour per kilometre, the problem resolves into two parts. For weights that could be carried, the formula given by Abrams (1989 : 70), stands without need for sensitivity variation. For larger stones, there is a very large variation. The figures used in the main energetics analysis, are for 9.1 P.Ds./tonne/km on the level or downhill and 13.6 P.Ds./tonne/km up a 5 ° slope. The lowest estimate is about 2 P.Ds./tonne/km (Coles) and the reasonable highest (Pollini), about 30 P.Ds./tonne/km. These two figures have been used in the sensitivity analysis.

6.3:4 <u>Preparation</u>

For Ggantija, very little preparation of materials was involved. The only large labour input postulated was for the preparation of torba. This involved grinding torba Globigerina limestone to a powder for use as a plaster. Abrams (1989 : 70) gives a figure of 20 P.Ds./tonne for the preparation of fired lime plaster, ie. quarrying limestone, obtaining timber and firing. This is a very different process from powdering limestone by pounding it. Nevertheless, Abrams' figure has been used. It may be wrong, and anywhere between 10 P.Ds./tonne and 30 P.Ds./tonne, correct. These figures have been used in the sensitivity analysis.

6.3:5 <u>Erection</u>

The sensitivity question here is in respect of the labour involved in the erection of large, ie. unliftable, stones. The existing data are very scant, as has been noted. The author has a figure of 1.5 P.Ds./tonne. In the sensitivity analysis, a lower assumed figure of 1.5 P.Ds./tonne has been used and a maximum figure of 7.0 P.Ds./tonne.

6.3:6 <u>Length of Work Periods</u>

A five hour working day has been assumed in all the author's calculations. This is based on Erasmus' (1965 : 285-6) work in the Yucatan, Mexico, where the high summer temperatures (reaching over 100°F at times) meant that the work rate dropped off after five hours. Abrams (1984 a : 153) for like reasons, uses a five and a half hour working day. Malta is very hot and humid in the summer months (with temperatures in the nineties Fahrenheit), when it has been assumed temple building took place in the slack period of the farming year. A five-hour working day therefore seem appropriate.

This may be too low: Renfrew (1979 a : 212-3) gives a figure of eight hours for Orkney. Pollini (1987 : 144) uses a figure of ten hours. For the purposes of the sensitivity analysis, a minimum figure of 5 hours/day and a maximum of 10 hours/day, are used.

The other work period, which must be questioned, is the conversion of person-days to person-years. The figures presented assume a ninety-day working year, utilising the agricultural off-season. Abrams (1989 : 66) suggests a figure between 60 and 100 days. But of course, a "professional" workforce could be postulated working say 300 days per year. No account has been taken of this consideration in the sensitivity analysis. Dividing the given years by three, would give an approximation of the number of "professional" years.

Table 6.4 tabulates the results of the above assessment. In each set of figures, for example the South Temple, the central column carries forward figures from Table 6.1 and on either side the amount by which these figures should be decreased or increased.

6.3:7 <u>Sensitivity Analysis : Summary Figures</u>

The figures given in table 6.4, may be surmised as follows, where sensitivity variations occur:-

SENSITIVITY ANALYSIS

Note : "CENTRAL" in this table Denotes the figures used in The main Energetics Analysis

ITEM	SOUTH TEMPLE LESS P.Ds.	SOUTH TEMPLE CENTRAL P.Ds. EFFECTED	SOUTH TEMPLE MORE P.Ds.	NORTH TEMPLE LESS P.Ds.	NORTH TEMPLE CENTRAL P.Ds. EFFECTED	NORTH TEMPLE MORE P.Ds.	TARXIEN PERIOD TERRACE LESS P.Ds.	TARXIEN PERIOD TERRACE CENTRAL P.Ds. EFFECTED	TARXIEN PERIOD TERRACE MORE P.Ds.	TOTALS LESS P.Ds	TOTALS CENTRAL P.Ds. EFFECTED	TOTALS MORE P.Ds.
1. Differences arising from wall height variation	Nil	10,154	1,320	Nil	3,284	427		-	-	Nil	13,438	1,747
2. Differences arising from stone procurement variations	414	844	1,595	200	409	773	234	477	902	848	1,730	3,270
3. Differences arising from large stone transportation	2,948	3,780	8,543	1,566	2,008	4,538	2,140	2,743	6,199	6,654	8,531	19,280
4. Differences arising from torba plaster preparation	700	1,400	2,100	420	840	1,260		-		1,120	2,240	1,120
5. Differences arising from large stone erection	Nil	1,180	4,331	Nil	728	2,672	Nil	1,143	4,195	Nil	3,051	11,198
6. Differences arising from the length of the working day	7,765	15,529	Nil	3,332	6,664	Nil	4,090	8,179	Nil	15,187	30,372	Nil
7. Totals based on adding the above figures	11,827	(15,529)	17,889	5,518	(6,664)	9,670	6,464	(8,179)	11,296	23,809	30,372	36,609
8. Totals arising from the cumulative effect of 1,2,3,4,5.	Nil		1,876	Nil		1,037	Nil		1,468	Nil		4,381
9. Grand Totals	11,827		19,765	5,518		10,707	6,464		12,764	23,809		40,990
10. Grand Totals of Total P.Ds.	Lower 3,702	Central 15,529	Upper 35,296	Lower 1,146	Central 6,664	Upper 17,371	Lower 1,715	Central 8,179	Upper 20,943	Lower 6,563	Central 30,372	Upper 71,362

Table 6.4

	Min/Central/Max	Expressed as % Min/Central/Max
Quantities arising from wall height variation: metres (wall and infill)	8.5/8.5/9.5	100/100/113
Procurement: stones: P.Ds./tonne	0.23/0.45/1.3	51/100/289
Transport: large stones: P.Ds./tonne	2/9.2/30	22/100/326
Preparation: torba: P.Ds./tonne	10/20/30	50/100/150
Erection: large stones: P.Ds./tonne	1.5/1.5/7.0	100/100/467
Working day: hours	5/5/10	50/100/100

Bringing together all this data, we arrive at the following figures :

	Lowest Estimate Person-Years	Central Estimate Person-Years	Highest Estimate Person-Years
For the South Temple	41	173	392
For the North Temple	13	74	193
For the "Tarxien" Terrace	19	91	232
Total	73	338	817

In terms of considering the labour demand on the relevant population, the central and lower and upper limits are considered in the next chapter.

6.4 PREVIOUS ENERGETICS ANALYSES

The only previous energetics work done for the Maltese temples, is that of Pollini (1987). He worked from photographs and drawings and calculated the labour input involved in the remaining buildings at Hagar Qim, Ggantija and the best preserved one at Tarxien. He says "[The] results [are] expected to have a possibility of error of less than 10% on average". [*Sic*] (*op. cit.*133).

He worked on the basis of counting the number of stones involved, which he divided as follows:

Small < 1cu m and approx. 2.5 tonnes

Medium 1-2cu m and 2-5 tonnes

Large 3.5cu m and 7-15 tonnes

He assumed that transport was along pre-prepared stone trackways, using wooden rollers or the stone spheres found at temple sites, aided with levers, and that the average distance travelled was 1km. The trackway stones were reused in building construction. Considerable effort was put into dressing stones, even at Ggantija. Erection involved levering stones into position, including levering them upwards when above the first course.

The results of his analysis are given in table 6.5. Pollini's original data are expressed in person-hours, but he reckoned on a ten hour working day, so his figures have been converted to person-days (P.Ds.). Apart from this, his quantities and the work involved per unit, are as expressed by him. Alongside his figures are the author's work rates, applied to the existing Ggantija remains (ie. not increased by the dimensions assumed for the original buildings, as Pollini made no such assumptions).

There are clearly major differences. Pollini's total is for 409,600 P.Ds. Whereas the author's, for a like building, is 3,664 P.Ds., and for the total remaining edifice, is 9,028 P.Ds.

Comparison Of Pollini's Figures With Those Of The Author

OPERATIONS	Size	POLLINI Est. No.	P.Ds./ Unit	Sub Total P.Ds.	Total P.Ds.	POLLINI DERIVED BY AUTHOR Tonnes/ Unit	P.Ds./ Tonne	Total Tonnes	>2 Tonnes	<2 Tonnes	AUTHOR P.Ds./ Tonne	Sub Total P.Ds.	Total P.Ds.
Preparing Temple Ground				5,000	5,000					234	1.53	358	358
Quarrying/Transport to Track	Small	3,000	3	9,000		2.5	1.2	7,500		559	0.45	252	
	Medium	320	17	5,500		3.5	4.9	1,120	359		0.45	162	
	Large	75	23	1,700		11.0	2.1	825					414
Sub Total					16,200			9,445					
Dressing		3,395	15	8,200	8,200		0.9		60		5.0	300	300
Building Track				51,000	51,000								
Transport	Small	3,000	60	180,000		2.5	24.0	7,500		559	0.7	391	
	Medium	320	250	83,000		3.5	74.0	1,120	359		3.6	1,292	1,683
	Large	75	500	38,000	301,000	11.0	46.0	825					
Placing Horizontals At Ground	Medium	200	11	2,200		3.5	3.1	700					
Level	Large	25	18	4,500		11.0	16.3	275					
Placing Horizontals above Ground	Small	3,000	5	15,000		2.5	2.0	7,500	359		1.6	574	
Level	Medium	30	23	700		3.5	6.7	105		559	0.6	335	909
	Large	10	65	700		11.0	6.4	110					
Placing Verticals At Ground Level	Medium	90	25	2,300		3.5	7.3	315					
	Large	40	70	2,800				440					
Sub Total					28,200								3,664
Totals Ref. Pollini					409,600								
Plus Author's Est. of Internal Rubble										2,750		3,240	
Plus Author's Est. of Terrace Rubble										360		371	3,611
Author's Total													7,275

Table 6.5

This difference of a hundredfold, like for like, needs serious consideration. In what follows, the author's central figures have been used: the maximum figures, in the sensitivity analysis, would change the comparison but not to a major degree.

<u>The quantities involved</u>: Pollini based his work on the number of stones involved in construction. It seems likely that this methodology was based on the dressed stone Globigerina limestone construction of Hagar Qim and Tarxien, which was then extended, inappropriately, to Ggantija. Using Pollini's total stone numbers and his average weight figures, given above, a total of 9,445 tonnes is arrived at. This compares with the author's figure of 918 tonnes and a ratio between the two of 10.3:1.

A cross check was made on the author's figure. The existing perimeter wall is 122m long and an estimated 0.7m thick and 5.0m high. This gives a total equal to :

122 x 0.7 x 5.0 = 427cu m or at 1.25 tonnes/cu m, allowing for interstices = 534 tonnes.

And the apse walls are 173m long and an estimated 0.4m thick and 5m high, giving:

173 x 0.4 x 5 = 346cu m or at 1.25 "sg" = 433 tonnes.

Taken together, these total 967 tonnes. This compares with the 918 tonnes calculated by the author from detailed measurements. Thus one can have confidence in the author's figure of 918 tonnes, rather than Pollini's extrapolated figure of 9,445 tonnes ie. a ratio greater than 10:1.

It may be noted in parenthesis, on the other side of the quantity equation is the fact that Pollini made no allowance for the very large quantity of rubble infilling between the outer and inner walls, and to a lesser degree, forming the two temples' original terraces. In total, amounting to some 3,110 tonnes.

Procurement: Pollini has made a curious calculation in relation to quarrying and transport. He has added together, quarrying and moving the stones to the trackway, as one element, and transport along the trackway, as another. This makes comparison difficult. Judging from the data Pollini gives on p.136, some 90% of the first element is involved in transport. If this is correct, we get the following:

	Pollini P.Ds.	Author P.Ds.
Procurement (excluding rubble)	1,620	414
Transport element in "transport to track"	14,600	N/A

While there is a 4:1 difference in procurement effort for a much larger total quantity (ie. Pollini's unit labour effort is lower), the totals involved are not significant in relation to the overall totals.

Transport: It is here that the single, largest differences between Pollini's figures and the author's lie:

	Pollini P.Ds.	Author P.Ds.
Transport under "transport"	301,000	
Transport under "transport to track"	2,000	
Sub Total	303,000	1,683
Trackway construction	51,000	-
Total	354,000	1,683

There are three major factors accounting for the difference:

1. Quantities involved (see above)

	Pollini Tonnes	Author Tonnes
Excluding rubble infill	9,445	918
Rubble infill		3,110
Totals	9,445	4,028

2. Distances Travelled: Pollini assumes 1km for all materials. The author assumes different distances:

   0.2km for rubble and small stones (Coralline limestone)

   0.4km for larger stones (Coralline limestone)

   1.2km for Globigerina limestone material

   The bulk of the material used is Coralline limestone.

3. Methods used: as mentioned above, Pollini assumes transport by levering along a prepared trackway, using rollers and levers, and that all stones have to be transported thus.

   The author assumes that rubble and small stones (<2 tonnes) are carried and that larger stones are dragged on sleds.

   The figures are:

	Pollini P.Ds./km/tonne	Author P.Ds./km/tonne
Small stones, rubble		3.5
Small stones	28	
Medium stones	71	
Large stones	45	10.0

As the author assumes the major quantity of the material used at Ggantija, was carried

(3,903 tonnes, including rubble), and only 359 tonnes were dragged, the methods involved average 4.0 P.Ds./km/tonne, compared with Pollini's weighted average of 35 P.Ds./km/tonne.

Dressing: Here Pollini gives a total of 8,200 P.Ds. based, it appears, on a discounted value of dressing costs at Hagar Qim and Tarxien, because the Ggantija blocks are less dressed. The author believes the majority of stones at Ggantija (Coralline limestone) were not dressed and the minority of blocks of Globigerina limestone (for instance, for portal jambs) were.

The resulting figures are:

	Pollini P.Ds.	Author P.Ds.
Dressing stones	8,200	300

Preparation of building site: Pollini gives a total of 5,000 P.Ds., based on 5 P.Ds. per square metre, to cover earth moving and levelling. The author has allowed 358 P.Ds. for only minor excavation and levelling up with rubble. This may be too low, but it is difficult to see why 5 P.Ds. would be required per sq m. In the summary that follows, 1 P.Ds. has been allowed, giving a total of 1,000 P.Ds.

Erection

	Pollini			Author		
	Tonnes	P.Ds./Tonne	P.Ds.	Tonnes	P.Ds./Tonne	P.Ds.
Stones	9,445	3	28,200	918	1	909
Rubble	-			3,110	0.6	1,866
Total			28,200			2,775

The differences here are again very large, partly accounted for by the 10:1 weight discrepancy already mentioned, and partly by Pollini's per tonne erection estimates being three times the author's.

Overall: The differences between Pollini and the author, are huge, amounting, as has been noted, to 409,600 P.Ds. for Pollini, and 3,664 P.Ds. for the author, when comparing the construction of the edifice Pollini assumes.

In conclusion, and in justification of the author's figures compared with Pollini's, the following summary is presented:

Procurement: There is a negligible difference in relation to the total.

Transport: Here, there are three elements involved in the difference between Pollini's figures of 354,000 P.Ds. and the author's of 1,683 P.Ds.

1. Quantities: Applying the ratio of 10.3:1 given above, would reduce Pollini's figure to 34,359 P.Ds.

2. Methods used: Applying the author's figure of 4.0 P.Ds./tonne, rather than Pollini's of 35 P.Ds/tonne, further reduces the 34,359 P.Ds. above to 3,927 P.Ds.

3. The balance of the difference between the above 3,927 P.Ds. and the author's 1,683 P.Ds., is accounted for by the difference in the postulated transport distances.

Dressing: Pollini's figure is 8,200 P.Ds. and the author's 300 P.Ds. Pollini's figure is not justified by the amount of dressed stone at Ggantija and the author's is to be preferred.

__Preparing building site__: An adjusted figure of 1,000 P.Ds. was suggested above.

__Erection__: Pollini gives a figure of 28,200 P.Ds. and the author a comparable figure of 909 P.Ds.

1. Quantities involved: Applying the 10.3:1 ratio reduces the 28,200 to 2,738 P.Ds.

2. The difference in the labour per tonne ratio, is 3:1. Applying this to 2,738 further reduces the figure to 913 P.Ds.

Adding together Pollini's adjusted totals, as above, gives the following:

Adjusted Pollini Totals

Procurement	1,620 (no adjustment made)
Transport	1,683
Dressing	300
Preparation of Site	1,000
Erection	913
Total	5,516

It should be remembered that Pollini postulated a 10 hour day and the author's, a 5 hour one. For final comparison with Pollini, the author's figure of 3,664 P.Ds. should be halved to 1,832 P.Ds. Both figures are well within the sensitivity parameters considered earlier.

Earlier, the author has assumed a ninety day working year, allowing for work to take place in the slack part of the farming year. Applying these figure to the person days, Pollini's figures equate to 4,551 person-years, whereas the author's equal 41 person-years, or allowing for the rubble used (which Pollini did not), 100 person-years.

CHAPTER 7

POPULATION

7.1 INTRODUCTION

There are three elements in an energetics analysis which together lead to an assessment of a society's contribution to its monuments:

- The labour involved in the construction of monuments.
- The size of the pool (or population) from which this labour was drawn.
- The length of time over which the monuments were constructed.

The first of these was discussed in Chapter 6. The last is the subject, *inter alia*, of Chapter 8. The middle element is the subject of the present chapter.

Estimating prehistoric populations is notoriously difficult. There are various approaches which may be taken:

1. An assessment based on the size and number of known habitation sites, with estimates of original numbers
2. An assessment based on burial numbers.
3. An assessment based on the carrying capacity of the territory concerned and its utilization.
4. An assessment based on known and relevant historical data.

In the context of the Temple Building period on the Maltese islands, the first two are not open avenues: there are virtually no known habitation sites. Two burial sites are known, that at Hal Saflieni near Tarxien, which contained perhaps 6,000 minimum number of individuals and at the Xaghra Stone Circle which contained "hundreds, perhaps thousands" of individuals (Malone and colleagues 1993 : 81). As these were in use from c4000-2500

BC, they provide no useful insight into population numbers. (Though it might be remarked that Cassar (1997 : 138) suggests that the Hal Saflieni figure could indicate a population of over 8000: "indicating a larger population than the land could safely support". This appears to the author to be an unjustified deduction.) The last two avenues are the ones explored here.

7.2 CARRYING CAPACITY

The land areas involved are:

	Sq kms	Hectares
Malta	246	24,600
Comino	3	300
Gozo	67	6,700
Total	316	31,600

It is not the total land area that is important, but rather that suitable for arable agriculture. For both major islands, the modern figure (which includes land now covered by urban development) is 60% (eg. Ransley 1974 : 22, Renfrew 1973 a : 153). Considerable soil erosion has taken place since the temple building period and this gives rise to Renfrew's estimate (1973 a : 153) of a higher figure of 70% of arable land available.

Against Renfrew's uplift, it has been argued in Chapter 5, that there were many more trees in Temple Building period Malta, than is the case today. Thus, although 70% of land may theoretically have been available, allowance for stands of trees suggests that the figure of 60% is the best estimate. Use of this figure produces the following:

	Total Ha.	Agriculturally useable arable Ha. @ 60%
Gozo	6,700	4,020
Maltese Islands	31,600	18,960

The other variables to consider are the degree of useable arable land utilisation and the density of occupation of that land. For the temple building period, we have no idea of the population pressure on land use. For the purposes of this analysis, figures of 30%, 70% and 100 % of land use have been taken. (It is worth noting that Renfrew (1973 a: 153-155) has taken the maximum figure.) A central figure of 70% of land use has been employed in this analysis.

It could, however, be argued that the advent of temple building was triggered by the stresses of population pressures brought about by 100% land use and the consequent social pressures for territory marking. This argument might have more relevance to Malta where there are several major temple complexes, but nevertheless could apply to Gozo. It has certainly been suggested (eg. by Renfrew 1973 a: 144) that the genesis of north west European megalithic monuments, found in the main in coastal regions, lay in population pressure deriving from westward migrations of people being baulked by the Atlantic of the possibility of further movement. Allowance has therefore been made in the sensitivity analysis which follows that there may indeed have been 100% land utilisation.

In the absence of firm data, the density of occupation estimates may vary widely. Renfrew (1973 a: 155) quotes and rejects a figure of 43.5 Ha. per person appropriate to semi-arid south Iran in the early farming period. Startin and Bradley (1981 : 294) quote Green (1974) as suggesting 10 Ha. per person, as relevant to Bronze Age Wessex, England. Said-Zammit (1997 : 36), in relation to Iron Age Mediterranean farm holdings, quotes 5.4 Ha.

per family and from Bronze Age Greece, an average family of 5.0 (both figures from Bintliff, personal communication and 1977 : 83), which gives a figure of 1.1 Ha. per person.

Renfrew (1973 a: 155) uses a figure of 2.0 Ha. per person.

For the purposes of this analysis a central figure of 2 Ha. per person, +/- 50% for sensitivity purposes, has been taken. In the next section, the reasonableness of this assessment is checked against available historical data.

7.3 HISTORICAL POPULATION DATA

Luttrell (1975 : 37-40) notes a population census record dating from 1241 AD, as follows:

	Number of Families
Malta	753
Gozo	366
TOTAL	1119

This record is subdivided into Christians, Muslims and Jews. The extant record survives as a result of successive copying and recopying, and Luttrell plausibly argues, in detail, that the 47 Christian families recorded for Malta (compared with 203 for Gozo) should in fact read 1047. This gives a revised table:

	Numbers of Families
Malta	1753
Gozo	366
TOTAL	2119

This, Luttrell states, produces a reasonable total population of 10,000. Blouet (1993 : 40) thinks this is too high given the likely technology of this thirteenth century agriculture and suggests a: "total population nearer to 5000 than 10,000", though he gives no details of the agriculture in question.

Using the two sets of figures, given above, for the area of agriculturally useable arable land and the Medieval population, the following numbers can be derived for the Maltese Islands:

	Total Ha.	Total Population	Ha./ Person
Luttrell	18,960	10,000	1.9
Blouet	18,960	5,000	3.8

If one assumes that both Neolithic and Medieval agriculture involved farmsteads employing mixed farming methods, that is crops and animals, there is no reason to suppose that the carrying capacity of the land differed between the two periods. Labour input may have differed but that does not invalidate the figures suggested in 7.3.

7.4 TEMPLE BUILDING LABOUR

The figures given above embrace the total population. Consideration must be given to what proportion of the total would be competent to assist in temple building. Most authors assume that such work was done by adult men, though perhaps on not always good grounds (Patton 1993 : 9). On skeletal burial evidence at the Neolithic tomb at Isbister, Orkney, Hedges (1983, 1984) derived the figure of 20-25 adult males percent of the total population, ie. 1 in 5 - 1 in 4. Renfrew (1973 c: 549) though without discussing the gender question, suggested that "one fifth of the population could be mobilised for public works for three months of the year". (The months were not given, but presumably were during the agricultural "off" season). In the matter of which sex did what, it may be observed that the heavier work, ie. stone quarrying, transport and erection, was probably carried out by men. On the other hand, rubble procurement, transportation and application, could well have been carried out by women, as could the preparation and application of torba. It may be reasonable to assume that both adult males and females were not simultaneously occupied on temple construction from a given homestead.

Given this assumption, the figures below are based on one fifth of the population being available for temple construction during the annual building period, that is for three months where agricultural demands were low:

	Gozo			Total Maltese Islands		
Total Ha.		6700			31600	
Agricultural Ha.		4020			18960	
Calculation 1: (varying land, utlisation, constant 2 Ha./person available)						
Ha./person available	2	2	2	2	2	2
Land utilization %	30	70	100	30	70	100
Persons available	121	282	402	569	1327	1896
Total population = above x 5	605	1410	2010	2845	6635	9480
Calculation 2: (Varying Ha./person constant land utilisation at 70%)						
Land utilisation at 70%	70	70	70	70	70	70
Ha./person available	3	2	1	3	2	1
Persons available	188	282	563	885	1327	2654
Total population = above x 5	940	1410	2815	4425	6635	13270
Calculation 3: (Varying land utilisation and Ha./person available)						
Land utilisation %	30	70	100	30	70	100
Ha./person available	3	2	1	3	2	1
Persons available	80	282	804	379	1327	3792
Total population = above x 5	400	1410	4020	1895	6635	18960

Table 7.1 Availability of Building Labour

It will be noted from the above figures, that the total population of the Maltese Islands, assuming 100% use of 60% (agriculturally available arable) land and 2 Ha. per family, is 9,480. Renfrew (1973 a: 153-55) assumes 100% and 70%, giving a figure of c.11,000.

Luttrell quoted above gives a figure of 10,000 for medieval Malta. These figures would correspond to approximately the 2,010 total or 402 persons available for temple building for Gozo in the table above (60% arable land, 100% land use, 2 Ha. per person).
The author's preference, but one based only on the supposition that human exploitation is rarely pushed to its limits, is for 70% land use at 2 Ha. per person. For Gozo, this gives a total population of 1,410 and 282 persons available for temple building: the "central" figures. With these figures may be compared Luttrell's figure for medieval Gozo of 366 families which could provide a like figure of available labour.

The next chapter considers these figures and the more extreme population postulates in relation to the various estimates of temple building labour requirements.

CHAPTER 8

LABOUR REQUIRED AND LABOUR AVAILABLE

8.1 INTRODUCTION

Chapter 6 set out figures for the labour requirement to build Ggantija and Chapter 7 figures for labour availability. This chapter brings these two sets of figures together and comments on the sort of strain demands for temple building labour may have put upon the community.

As has been said earlier (Chapter 4, section 3), Ggantija was built in three distinct phases:

- first the South Temple
- then the North Temple, both being built during the Ggantija Period, followed by
- the Temple platform, built in the Tarxien Period.

These three edifices are considered separately. There is a very large number of figures to consider and for the sake of simplicity, the "central" figures, ie. the author's preferred ones, are taken first, followed by consideration of the implications of the sensitivity analyses. Comment is also made on the implications of Pollini's analysis.

Taking the South Temple by way of example, it will be seen from the table that follows that 15,529 person-days were required and that 282 persons were available. Theoretically this implies that if all 282 worked at once, the temple could be built in 55 days. It is however, unrealistic to assume that all 282 could be organised to work at once. For one thing, the building sequence dictates that stones have to be quarried before they are transported, and transported before they are erected. If dressing is involved, this has to be incorporated in the sequence. Rubble infill cannot be put in place until the walls are at least partway built and the roof cannot be constructed until the temple is, in other respects, complete. It is unlikely but possible that the sequences might be followed and completed in the postulated ninety day-year. It is more likely that a longer period was taken. If, say, three years were taken then instead of each available worker needing to provide 55 days, this figure would be divided by 3, giving a total per available person, per year of about 18. If each worker had 90 days maximum availability, then only 20% of this time would be required each year (or expressed another way, 5% of the worker's 365 day year). This reasoning is developed further in section 8.4.

An alternative possibility is to postulate that a "professional" workforce was employed: that is the community supported a permanent workforce engaged in building the temple. If the task was to be completed in three years, it would require: $\frac{15529}{365x3}$ = 14 persons working every day. This in fact is not feasible because the transport and erection of the largest stones would, at times, require say 200 persons. It would of course have been possible to combine a "professional" force with occasional input from a much larger band of volunteers (pleased perhaps, at contributing to the temple's construction). It is suggested later that the structure of the temple building society was unlikely to have been one where a "professional" force could have been organised and, alternatively, arranging for the use, on a part-time basis, of the available workforce would have been the system adopted. Whether this was a low labour time requirement throughout the year (5% as calculated above) or a larger requirement (20%) during the agricultural off season, must be a matter of conjecture. Ethnographic examples (eg. Abrams 1989 : 66, Erasmus 1965 : 280-1) suggest that at any rate for domestic buildings, the agricultural off-season was used for construction.

The table (8.1) that follows presents figures that follow this line of reasoning, based on the author's central figures. It must of course be pointed out that the three year period chosen is entirely arbitrary. It could be any period up to what might be regarded as a maximum (10 years? or 25 years?) during which community interest might be sustained and the leaders of the project driving force maintained. As the total labour requirements, in person or percentage terms, are so low for even three years, it does not seem fruitful to produce figures for a longer period than the three years suggested.

8.2 LABOUR REQUIRED & LABOUR AVAILABLE: "CENTRAL" FIGURES

	South Temple	North Temple	Platform
Total labour required P.Ds.	*15,529*	*6,664*	*8,179*
No. of person-years required assuming a 90 day working year (ie. P.Ds. divided by 90)	173	74	91
Total population of Gozo	1,410	1,410	1,410
Workforce available assuming one fifth of total	282	282	282
No. of days required from each of the available workers	55	24	29
No. of days required from each worker year assuming a three year building period	18	8	10
% that that figure represents of the worker's 90 day slack farming period	20%	9%	11%
% that that workload represents of the worker's 365 day year	5%	2%	2%

Table 8.1 Labour Required & Labour Available: "Central" Figures. (From Tables 6.1 and 7.1)

Before discussing the implications of these figures, it is appropriate to conduct a sensitivity analysis. Such an analysis has been carried out in respect of labour requirements in Chapter 6 and for population figures in Chapter 7.

For each of the South Temple, the North Temple and the Tarxien platform the sensitivities have been presented in three ways:

1. Extremes of labour required, "central" labour availability.
2. "Central" labour required, extremes of labour availability.
3. Extremes of both labour required and labour availability.

In the tables that follow, these three possibilities have been identified by the numbers above. (Table 8.2)

8.3 OBSERVATIONS ON THE "CENTRAL" FIGURES

Casual observation of the Ggantija temples and their later platform give the impression of a massive contribution of labour by the relatively low density "copper age" agricultural community. If the casual observer then tries to envisage the original form of the temples, this already large contribution becomes even greater. Similar observations have been made for example, about Stonehenge, England and Mayan ceremonial complexes in Mesoamerica.

But examination of the figures in Table 8.2 presents a different view. First it must be reiterated that the Ggantija complex was built in three distinct phases, possibly widely separated, and thus spacing out demands for labour.

Section 8.2 above, postulated that if a three year building period, for the largest construction, the South Temple, were assumed, the demands on the available work force of 282 represented 20% of each worker's time available if this was 90 days per year, or 5% of the worker's time, assuming availability for 365 days per year.

Labour Required & Labour Available : Sensitivity Analysis

Total Population	4,020	1,410	400
Workforce Available Assuming One Fifth	804	282	80
Labour Required :	Minimum	"Central"	Maximum
SOUTH TEMPLE			
Labour Required : P.Ds.	3,702	15,529	35,294
1. Number of days from each individual : variable requirement, "Central" availability.	13	55	125
1. % this represents of individual's 90 days assuming three year building period.	5%	20%	46%
2. Number of days from each individual : "Central" requirement, variable availability.	19	55	194
2. % this represents of individual's 90 days assuming three year building period.	7%	20%	72%
3. Number of Days from each individual : variable requirement and availability	5	55	441
3. % this represents of individual's 90 days assuming three year building period.	2%	20%	163%
NORTH TEMPLE			
Labour Required	1,146	6,664	17,371
1. Number of days from each individual : variable requirement, "Central" availability	4	24	83
1. % this represents of individual's 90 days assuming three year building period	1%	9%	31%
2. Number of days from each individual : "Central" requirement, variable availability.	8	24	83
2. % this represents of individual's 90 days assuming three year building period.	3%	9%	31%
3. Number of days from each individual : variable requirement and availability.	1	24	217
3. % this represents of individual's 90 days assuming three year building period.	1%	9%	80%
"TARXIEN" PLATFORM			
Labour required	1,715	8,179	20,943
1. Number of days from each individual : variable requirement, "Central" availability.	6	29	74
1. % this represents of individual's 90 days assuming three year building period.	2%	11%	27%
2. Number of days from each individual : "Central" requirement, variable availability.	10	29	102
2. % this represents of individual's 90 days assuming three year building period.	4%	11%	38%
3. Number of days from each individual : variable requirement and availability.	2	29	262
3. % this represents of individuals 90 days assuming three year building period.	1%	11%	97%

Table 8.2 Labour Sensitivity Analysis

This represents no great strain on the community. It may be compared to the figure (Webster 1991 : 853) derives for the construction of single tower nuraghi on Iron Age Sardinia of 10 P.Ds. per year, also imposing structures. For the even more impressive "Nunnery Quadrangle" at Uxmal, Mexico, Erasmus (1965 : 296-7) calculates that with a contribution of 40 man-days per year, the Nunnery could have been built in 14 years. So even this much more massive construction (650,000 man-days required) involved a low level strain on the relevant community. For Stonehenge IIIa, England (the standing stones), Startin and Bradley (1981 : 294) suggest an involvement of 1% of the population constantly working.

A word should be said here about the one aspect of temple construction that involved specialised craftsmanship: that of surface carving. The labour involved here was limited, estimated at 12 days (see Table 6.1). Kaplan (1963 : 403) says: "... the artistry of a product is frequently no clue as to whether its maker was a full-time or part-time artisan". Lacking evidence to the contrary, it seems safe to assume that this work, as all others involved in temple building, was done by part-time workers.

8.4 OBSERVATIONS ON THE SENSITIVITY ANALYSIS FIGURES

These observations are again based on looking at the largest of the Ggantija edifices; the South Temple.

At the low extreme the temple required 3,702 P.Ds. and the labour force available numbered 804. This would require five days' work from each person, or 2% of their available time, assuming a 90 day work-year and three year building period. Although each component of the minimum number of total P.Ds. required in the temple construction might individually be justified, it seems most unlikely that each and every one is. Apart from observing that the labour requirements place minimal strain on the building community, it does not seem fruitful to comment further. Even looking at the figures deriving from using "central" labour availability and variable building requirements, or "central" building requirements and variable labour availability, we can still make the same observation: ie. strain on the community is negligible.

At the high extreme, the P.Ds. required for the South Temple number 35,294, compared with the "central" figure of 15,529 (127% higher) and the labour availability is 80 compared with 282 (28%). Using both these extreme figures, the number of days of work required from each worker is 441 and the requirement from each worker, assuming a 90 day work-year and a three year building period is 163%. That is, to build the temple in three years would require a building period of 90 x 1.63 = 147 days.

Other permutations are instructive, based on the figures of a labour requirement of 35,294 P.Ds. and a labour availability of 80 persons, and are set out below:

Building Period	Days per person per year	Percent this represents of a 90 day year	Percent this represents of a 365 day year
As above : 3 years	147	163%	41%
5 years	88	98%	25%
10 years	44	49%	12%
25 years	18	20%	5%

From the above it may be noted that a five year building period would require all of the available workers' time if they worked on temple building for 90 days per year. Half the available time per year would be required if the building period were 10 years, but would only represent 12% of their total time. A 25 year building period, by no means an implausibility, would require only 5% of each available worker's total full year time.

The total population postulated here is 400, based on 30% utilisation of available arable land and 3 Ha. per person: the population seems low after over 1,500 years of Neolithic occupation, and indeed possibly low in relation to the "critical mass" which might engage in such a construction as Ggantija. A further problem is that some of the largest stones would require more than 80 persons to transport them, though this is a problem that might have been overcome either by drafting in every available able bodied person on Gozo, (perhaps still falling short of 200) or soliciting help from nearby Malta. Alternatively, it might be suggested that had the local labour force, fully mobilised, been unable to move and erect the largest stones, society would have been willing to compromise and use smaller stones, despite the diminution of the monument's impressiveness. But such a compromise would have been unnecessary if the population was larger.

The other variation is that of the number of P.Ds. required for the South Temple's construction. This is something over double the number set out in the "central" estimate and produces a figure of 125 days per person, assuming that 282 are available (line 1 in Table 8.2). Over a three year building period, each individual would have to work 46% of his/her available 90 day work-year. This seems an entirely feasible proposition and if asked to hazard what are the probable figures, they seem likely to lie between the postulated "central" figures, with perhaps a chance of being up to 20% lower and 100% higher. Wherever the truth lies, the comments made about the absence of strain on society in the section on the "central" figures above, still apply.

8.5 COMMENTS ON POLLINI'S FIGURES

The inconsistencies and inaccuracies incorporated in Pollini's (1987) labour requirement figures have already been pointed out in Chapter 6. It is desirable at this point to consider the implications which acceptance of his figures would have for the time taken to construct the temples, by relating them to the available labour.

Pollini estimated the number of P.Ds. involved in the construction of the Ggantija complex as it may be seen today, without distinguishing any separate building phases. He considered only the walls and floor, and did not include either the rubble infill nor the "Tarxien" platform. For the construction he considered, he arrived at 409,000 P.Ds. The author's equivalent figure is a "central" one of 3,664. (See Table 6.5).

Using the author's "central" population figures, the comparison is as follows; using the author's "central" population and labour availability figures in both cases:

	Pollini	Author
Total population	1,410	1,410
Available Workers	282	282
Total P.Ds. required	409,600	3,664
Days required per available worker	1,452	13
Number of years involved at 90 days/year	16	0.14

The comparison becomes even more stark if one multiplies Pollini's figure of 409,600 for the existing walls by the author's estimate of the total labour required for both the South and North Temples, as originally built, of 22,193 P.Ds. (see Tables 6.1, 6.2 and 6.5) divided by the 3,664 P.Ds. above. That is correcting for Pollini's incomplete assessment of the existing structures and for his not assessing the work content of the original. The comparison then becomes:

	Pollini	Author
Pollini's figure x $\frac{22,193}{3,664}$: number of years	97	
Author's total figures: number of years		0.85

Pollini's figure of 16 years already seems a fairly long period to sustain effort, but when extrapolated to 97 years, it becomes unbelievable. It should perhaps be remarked that if one allows for the building of the South and North Temples in distinct phases, the South Temple required 70% of the total. Applying this to the 97 years above, produces 68 years: still an enormous figure and one which implies a 25% labour "tax" on available adults for 68 years. At the least, this must imply an autocratic society akin to the most coercive state systems, in a society of 1,410 persons. Had Pollini extended his investigation to include consideration of the time taken to build the temples, he might have been led to reconsider the validity of his labour requirement figures!

8.6 IN CONCLUSION

The central proposition put forward in this chapter is that the labour requirements to construct the Ggantija complex, did not pose a significant strain on the temple building period population of Gozo.

The next chapter explores whether such a finding throws any light on the structure of Gozo's society and attempts a comparison with other prehistoric societies.

CHAPTER 9

CONCLUSIONS

9.1 HAS AN ENERGETICS ANALYSIS THROWN NEW LIGHT ON THE TEMPLE BUILDING PERIOD IN MALTA?

Questions that an energetics analysis might hope to answer are:

1. Did the building of temples place a strain on Maltese society?
2. Does the analysis provide clues to the nature of Maltese temple period society?
3. Are there signs of societal development over time?
4. Was the utility of the energetics analysis, in relation to Malta, envisaged in Chapter 3, confirmed?

9.2 DID TEMPLE BUILDING CAUSE A STRAIN ON MALTESE SOCIETY?

It has been demonstrated in Chapter 4 that the Ggantija temple complex was built in three distinct phases. The first of these, the South Temple, was the one that had the highest labour requirements for its construction, and it is therefore this temple which has been concentrated on in Chapter 8, in relation to the effect which its construction might have had on the society which built it.

Using the author's "central", or preferred figures, construction required 15,529 person days (P.Ds.) of labour. If the temple was built only in the ninety days of each year that has been suggested as the "off season" for an agricultural community, and if a workforce of 282 persons was available, and if construction was spread over three years; then only 20% of each person's available time needed to be devoted to the temple's building. If, however, building was spread over the whole year, then only 5% of each available person's total time would be required.

In the sensitivity analysis, the lowest labour requirement figure for the South Temple suggested that, on the same basis as above, only 5% of a ninety day "year" or less than 2% for a full year, would be required of each person. But a concatenation of all the lowest labour requirement figures with the highest population density seemed unlikely.

The highest labour requirements combined with the lowest population figure would mean that over a three year building period, the available labour of 80 persons would each have to spend 147 days on temple building, or 40% of their total time. However, if the total building time was extended to five years, the temple construction would require 88 days from each person, just within the 90 days postulated as being available. By extension, the annual requirement would be halved to 44 days or half each person's available time for a ten year building period. A twenty five year period, by no means implausibly long, would require 18 days per person, per year, representing 20% of a ninety day year or 5% of a total year.

Most attention has been paid to the South Temple at Ggantija because it had the largest requirement for labour, and therefore was the most likely to cause stress on its builders. It is, however, worth reviewing briefly the results of the energetics analyses on the other two edifices at Ggantija. The North Temple, using the author's "central", or preferred, figures required 6664 person-days for its construction, and if 282 persons were the available workforce, and construction was spread over 3 years then if it was built during the 90 day agricultural off season, each person would have to devote 9% of their time. If building were spread over the whole year this figure falls to just over 2%. From the sensitivity analysis (Table 8.2), if the population is the minimum postulated, providing 80 persons available for temple building, and the labour required is the maximum, ie. 17,371 person-days, then for a three year building period each person must spend 80% of their 90 day availability each year or 20% of their total time. A longer building period would lessen these percentages in proportion and might be the more likely social response to the demands for labour.

Similar conclusions arise from consideration of the building of the Tarxien period terrace. Here the "central" figures indicate a demand for 11% of the time of available labour for a 90 day year for each of three years of 3% of each person's total year. For the maximum figures on the sensitivity analysis these two percentages become 97% and 25% respectively. As for the North Temple if these lower population figures and higher labour requirement figures are correct, it is likely that the building of the terrace would have been extended for a longer period than three years.

On this basis, even the highest figures do not indicate that temple building, per se, placed any undue strain on society. The lowest population figures set out were for 80 persons available, being one out of five of the total population. It may be asked whether a total population of 400 represents what might be termed a "critical mass" for envisaging, planning and constructing a major monument such as the Ggantija South Temple? It is instructive to look at the building of some of England's major parish churches. Hutton and Cook (1976 : 118) have an illuminating paragraph:

"It is the more astonishing that so many of the finest Perpendicular churches of England are in what were always small villages (at most seventy householders or taxpayers). [That is three to four hundred total population.] It is hard to realise how great was the compulsion, or impulsion, on our forefathers to lay out so much of their modest wherewithal upon their parish church and its contents. [Contents] which all still bear witness - - - to the high priority accorded - - - to the after-life and the powerful mediation of the Holy Church, especially in the local community". One should not push the analogy too far, but the parallels with Maltese temple building society are striking.

In considering the question of stress, two other developments on the Xaghra plateau, on which Ggantija stands, should be mentioned. Santa Verna is a small Ggantija period temple site of which little now remains. It is certainly much smaller than anything at Ggantija and as there is no evidence that it was built concurrently with either of the Ggantija temples, it does not appear necessary to include it in any assessment of strain. The other development is the hypogeum; the Xaghra Stone Circle. It has been described in Chapter 2. It was occupied and developed from the Zebbug period through to the Tarxien period. How much labour was expended in developing the series of natural caves, and at what dates, is not known, but as for Santa Verna this need not have been at the same time as the construction of Ggantija South Temple, and it can also be ignored from the aspect of additional stress.

Acceptance of Pollini's labour requirements for the construction of Ggantija would produce a totally different assessment of strain on society. But his figures were shown in Chapter 6 to be totally inaccurate and are only mentioned here for the sake of completeness.

The examples reviewed in Chapter 3 showed that even quite large monumental structures, built in prehistory, did not place an undue strain on society that built them. Possible exceptions were: Mayan ceremonial centres - these had a large population available and may have been made by a society approaching, or arrived at, statehood; On Easter Island, there has not been an energetics analysis, so whether the documented ecological disaster is the result of excessive monument construction and its labour demands, or other causes, or a combination, remains uncertain.

9.3 DOES THE ENERGETICS ANALYSIS PROVIDE CLUES TO THE NATURE OF MALTESE TEMPLE PERIOD SOCIETY?

An extensive review of the literature pertaining to pre-state society has been undertaken. Appendix 2 identifies the relevant entries within the bibliography of the whole dissertation. Earlier theories were based on research in the Pacific and were envisaged as an evolutionary progression, indeed sometimes even the steps of a ladder up which society climbed, the lowest rung being Bands, followed by Tribes, Chiefdoms and finally States. As further fieldwork and even further theorising progressed, it became clear that if such a framework was to be of use, an infinite number of variations of each rung must be admitted, and further that there was no inevitability in progression up the ladder.

Although states are, in general, categorised as involving tens of thousands of people with a centralised authority and able to employ coercive force, which was used to reinforce that authority and inherent inequalities, yet the distinction between complex chiefdoms and states was often blurred. Chapter 3 reviewed two such situations, in Hawaii and Mayan Mesoamerica. Smaller societies, such as those on Malta and Gozo, tend to have some form of tribe or chiefdom societal organisation. Any society produces, and indeed needs, leaders and leaders enjoy and cultivate power. An established subsistence society, based on Neolithic agriculture, and hence with a relatively low population density, does not need much organisation for its economic and social well being. There does need to be some means of resolving conflicts over land use, animal ownership and so on. The leaders who fulfil this function may be singular, chosen or accepted because of their ability, or plural such as a group of elders chosen perhaps by seniority. No hereditary principle needs to be involved.

But such a low level of organisation is not likely to have produced the temples or hypogea of the Maltese islands. For this, some form of "charismatic office" (Webster 1976 : 820) is needed. That is, there must have been some transformation from the simpler form of organisation described above into a more permanent "office".

Chapter 2 described the situation in the Maltese islands. Some 500 years before the start of the Ggantija temple building period, there appears in the Zebbug phase a new form of pottery, perhaps brought by new colonisers, with incised little men sometimes decorating it, and also a carved stone, stylised, anthropomorphic "menhir". By 3600 BC temple building started, and temples they were: they are clearly for worship and cult practice and sacrifice. They were not used for burial. The hypogea served this latter function, also incorporating ritual areas. Associated with both temples and hypogea are small and large carved figures, ranging from stick men to grotesquely obese figures. These are supplemented by relief carvings of animals and elaborately executed geometric patterns.

This was a religious society. What function the gods fulfilled is not known. It has been plausibly suggested that some form of fertility cult was involved, but the elaboration of the hypogea also suggests that ancestors were, at the least, venerated. "But the gods, being fictions, must have had real representatives, nominally their specialised servants, who must have done much to give concrete form to the imaginary beings, and by interpreting, must have invented their desires. Temples presuppose priesthoods. ... The construction of a temple was a co-operative task... The whole must be planned in advance". (Childe 1973 : 100-1) and then the work must be directed and co-ordinated.

So one may conclude that Malta, at the least, had a theocratic "charismatic office". Some minimum secular functions also had to be performed. Were the religious and secular office separated? There is no evidence for this: there are no extant secular monuments, nor aggrandising burial remains. (The hypogeum at Hal Saflieni is thought to have contained the remains of over 6000 individuals – certainly not the remains of all deaths in the area over 1000 years, but neither does it represent the remains of an elite few: the same pattern is apparent from the recent excavations at the Xaghra Stone Circle.) The necessary secular, societal functions could have been performed by the religious "office". What was the nature of that office? That it was in some way self-perpetuating is clear. But there is no sign of a single superior religious centre. Although the temple complex at Tarxien is larger and more complex than those at Hagar Qim, Mnajdra and Ggantija, it is not significantly so. And by analogy, there is no reason to suppose that such a single superior centre must have existed: Hellenistic Greek society had no such central religious authority.

Renfrew (1973 a: 152-5) suggested that the Maltese islands were occupied by perhaps six chiefdoms. He produced a map to demonstrate this possibility (Fig. 9.1)

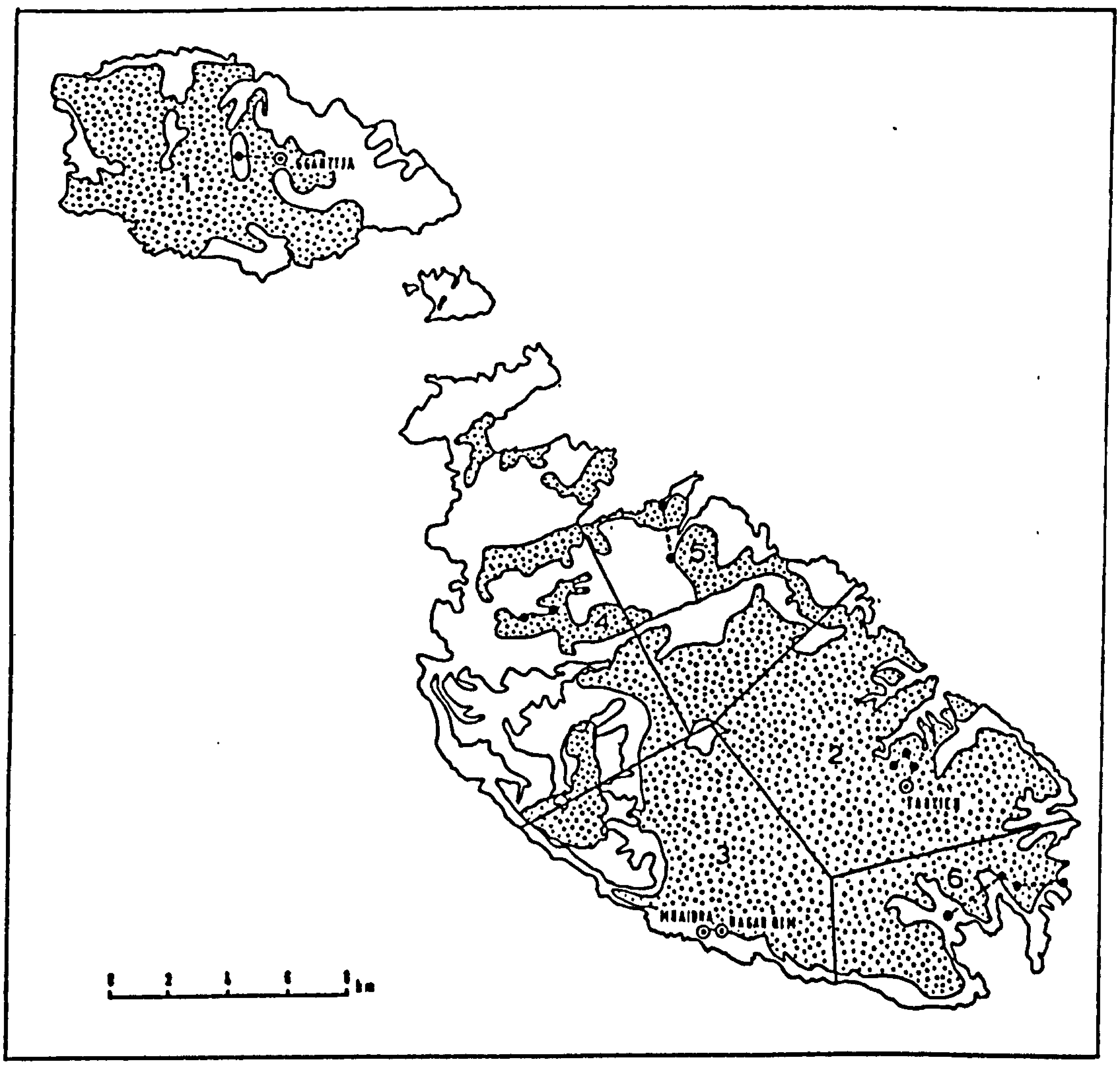


Fig. 9.1 The six pairs or clusters of temples in relation to modern, arable land (stippled) with hypothetical chiefdom territories, marked by the straight lines.

Later Renfrew and Level (1979 : 152-8), using the technique of Xtent analysis, suggested that it might be possible to postulate two centres of dominance on the Maltese islands; one based on Tarxien on Malta and the other on Ggantija on Malta. As has been noted in Chapter 2, some credence might be lent to this theory by the fact that the only two known hypogea, at Hal Saflieni and the Xaghra Stone Circle, share the same locations.

The two possible outlines of the structure of Maltese society noted above are possible, but suffer from two defects. One is that noted in Chapter 2; they do not take account of the pairing and clustering of the temples which might be taken to indicate intra as well as inter territorially divided society rivalries. The other is that they view what remains of the temple building society as a single manifestation and not as a situation developing over at least 800 years. Whatever the rivalries within or between regional societies, these were not settled by resort to weapons. There are none of significance found in the remains of the temple period – a remarkable and unusual feature. The energetics analysis does not throw much light on this quandary, except that the labour requirements for temple construction, spread over this period would certainly not militate against a fluctuating or changing territoriality or societal structure during the temple period.

9.4 DEVELOPMENT OVER TIME

Various strands of development over time may be discerned and are discussed below.

1. Temple types: As noted in Chapter 2, the earlier temples of the Ggantija period were built of undressed limestone blocks, whether of Coralline limestone or of Globigerina limestone. Later, Tarxien period, temples were built where Globigerina limestone was readily available. Some were built exclusively of Globigerina limestone (Tarxien, Hagar Qim), others of a combination (Mnajdra, built on Coralline limestone but with Globigerina limestone available close by). The Tarxien period Globigerina limestone was carefully dressed into fine ashlar blocks, which was easily done, even using Neolithic tools, when the stone was first quarried. Use of such blocks gave an altogether more sophisticated appearance to both the exteriors and interiors of the temples. It is noteworthy that no Tarxien period temples were built on sites without access to Globigerina limestone other than Skorba east, and furthermore that no new temples were built in the Tarxien period on Gozo. The large, additional platform at Ggantija was built in the Tarxien period, and may reflect a change in cult practices, or an increase in population, or both.

2. <u>Contents</u>: There is a problem here, namely that differential preservation may give a distorted view of the elaboration of temple contents in the Tarxien period. It can be stated that the elaboration and skill involved in the furnishings of the Tarxien temples themselves, were of a high order. We cannot know whether, for example, sacrifice was practised in pre-Tarxien periods but it seems likely. The evolution of anthropomorphic figures is however clear, as has been discussed in Chapter 2. The very obese, sexless (ie. with no discernible sexual attributes) figures make their appearance in the Tarxien period, and probably indicate a developing religion or cult practice.

3. <u>Exclusivity</u>: Over the temple building period there is a distinct increase in the degree of exclusion from inner temple areas, coupled with the apparatus of contrived mystery – the oracle holes and the manipulable "puppet" heads of the obese figures. It would seem that the priesthood was becoming increasingly elite and exclusive, and manipulating the general public; one might surmise as a means of enhancing their own power rather than as a means of improved communication with the divine to enhance the general weal.

4. <u>Trade and Contact</u>: There is very little evidence for trade throughout the temple period. Obsidian and flint and hard igneous rock for axes were necessary materials for the Neolithic society, but whether they were obtained by trade or foraging is not known. The same applies to red ochre, which though perhaps not a <u>necessity</u> in a subsistence sense was certainly <u>needed</u> by the temple period society. Some more exotic materials were imported: greenstone from Italy and perhaps pumice. There are some signs of diminution in these imports: stones were progressively reworked to the point where they became ornaments not tools. Culturally, after the probable influx of a new wave of immigrants at the start of the Zebbug period, there appears to have been very little cultural contact in either direction (always allowing that the Lipari islands, one of the sources of obsidian, were inhabited as was Sicily, the probable source of red ochre). Some authors cannot believe that there was

not significant contact, despite the lack of archaeological evidence: their argument is based on Malta's subsequent status as an entrepot, a status not achieved until the Phoenician opening of the sea lanes.

5. **The End:** of the temple period came abruptly in about 2500 BC. Trump (1976) gives a comprehensive assessment of possible causes. One possibility is war. The successors to the Tarxien culture, that of the Bronze Age Tarxien Cemetery, were clearly invaders bringing with them the trappings of an alien culture including metal weapons. It is not clear, however, whether there was a gap between the end of the Tarxien period and the beginning of the Tarxien Cemetery. There certainly was a gap in the use of the Tarxien site, evidenced by the accretion of a metre of sterile soil before the Tarxien Cemetery people started using it as a burial site. No such gap was evident at Skorba, though damage to the temple blocks preceded Bronze Age additions (Trump *op. cit.* 605). Social instability, involving revolt against an increasingly restrictive and dominant priesthood is another possible cause, but although possible would hardly have resulted in a complete disappearance of a culture. Disease, such as a plague, falls in a similar category: although a plague might have been calamitous, it would not have been totally destructive.

Economic factors are a further possible cause of the end of the Tarxien period culture. Deforestation, both to provide timber for building purposes and extra agricultural land, could have led to serious soil erosion, especially of some of Malta's lighter soil covered land. But again, this would hardly have led to the total disappearance of Tarxien culture. Another cause for the collapse, even if only a contributory one, is often advanced, that is the strain on society involved in temple building. "The number and size of the temples in their latest, Tarxien, phase necessitated a large labour force and so a substantial population" (Trump *op. cit.* 607). "Eventually the time and effort demanded [to construct "structures like the Ggantija or Hagar Qim temples"] - - - may even have assisted in bringing about the eventual breakdown of the system" (Evans 1977 : 23). It seems clear from the evidence set out in this thesis, that building the temples placed no great strain on the society that built them. Dating their construction is, as yet, imprecise, but there is no evidence of a sudden increase in building activity immediately before the collapse of Tarxien society.

Trump (*op. cit.* 607) points to the extreme variability in Malta's climate and the occurrence of drought years (see Chapter 2). If there was a succession of such droughts over five years, the effect would be disastrous. Bonanno (1990 a : 44) picks up this theme: "over-exploitation and eventual exhaustion of the natural resources, compounded by successive years of drought which forced the entire population to desert the island, seems so far the most plausible solution to the enigma". Trump (*op. cit.* 608) points out that as yet, no evidence of such an exodus has been found elsewhere, although this does not, of course, disprove the theory. The idea of a "Moses" leading his people to a chosen land is certainly romantic as well as being plausible.

9.5 HAS THE UTILITY OF THE ENERGETICS ANALYSIS, IN RELATION TO MALTA, ENVISAGED IN CHAPTER 3, BEEN CONFIRMED?

It may fairly be asserted that the energetics analysis has demonstrated that the labour required to construct Ggantija, in relation to Gozo's population, placed no great strain on the prehistoric Gozitan society. A strong motivating force (such as envisaged by Hutton and Cook, section 9.2 above) and organisation were required but the necessary labour was there to be mobilised. It may be argued that selecting one temple complex (Ggantija) is to ignore the possibility that other structures may have been more demanding. This may be the case, for instance at the Globigerina complex of Hagar Qim with its dressed stone construction. Hagar Qim may have required more labour in the dressing, but the difference would be one of degree not kind: the major labour requirement component is transport in both cases. Tarxien demonstrably demanded skilled labour for its carved furnishings, not present at Ggantija. As a cross check on this, the author commissioned an obese figure sculpture in Globigerina, measuring some 30 x 20 x 20cms, from a local Gozitan sculptor. This took him ten hours using metal tools. Doubling this to 20 hours to allow for Neolithic tools (Abrams 1984a : 168) gives an indication that the time taken to sculpt Tarxien figures would not have been excessive, and could, as suggested for Ggantija reliefs, been provided by part-time craftsmen.

Fig. 9.2 Sculptor Joe Xuereb with his obese figure.

It may also be said that the energetics analysis demonstrates that temple building, either in a direct way for labour or indirectly in its resultant effect on natural resources, did not contribute to any significant degree to the demise of the temple building society.

Finally, as a negative contribution by the energetics analysis reported herein, it has been demonstrated that an unthinking use of Pollini's (inaccurate) analysis would lead to very different conclusions regarding the strain temple building would have placed on temple period society.

APPENDIX 1

Figure Source References When Not The Author's Figures

2.1	Trump	1990	Fig. 3
2.2	Ridley	1976	p.10
2.3	Geological Map of the Maltese Islands : Oil Exploration Directorate : Malta 1993		
2.4	Geological Map of the Maltese Islands : Oil Exploration Directorate : Malta 1993		
2.5	Chetcuti, Buhagiar, Schembri and Ventura	1992	p.18
2.6	Chetcuti, Buhagiar, Schembri and Ventura	1992	p.16
2.7	Chetcuti, Buhagiar, Schembri and Ventura	1992	p.29
2.8	Trump	1981	Fig. 2
2.9	Bonanno	1990	(no page number)
2.10	Bonanno	1990	(no page number)
2.11	Bonanno	1990	(no page number)
2.12	Trump	1990	Fig. 32
2.13	Trump	1981	Fig. 11
2.14	Bonanno, Gouder, Malone and Stoddart	1990	Fig. 5
3.1	Erasmus	1965	p.282
4.3	Evans	1971	Plan 38 A
4.4	Evans	1971	Plan 38 B
4.6	Bonanno	1990	p.16
4.8	Ashby, Bradley, Peet & Tagliaferro	1913	Plate V
4.9	Zammit	1994	p.20
4.11	Ceschi	1939	p.47
4.12	Ceschi	1939	p.55
4.13	Ceschi	1939	Fig. 37
4.15	Ceschi	1939	Fig. 40
4.16	Ceschi	1939	Fig. 42
4.17	Ceschi	1939	Fig. 50
4.18	Piovanelli	1988	Fig. 1
4.19	Piovanelli	1988	Fig. 3
4.20	Zammit	1994	p.20
4.21	Evans	1959	Plate 76
4.22	Fsadric	1992	p.45
4.23	Fsadric	1992	p.45
4.27	National Library, Malta : reproduced in Pace	1996	p.24
4.28	Bonanno	1990	Front cover
4.30	Evans	1971	Plate 26
4.31	Evans	1971	Plate 26
4.33	Evans	1971	Fig. 65
4.34	Pace	1996	p.30
4.35	Evans	1971	Plate 28
5.1	Mapping Unit : Malta 1988 Geological map : Oil Exploration Directorate : Malta 1993		

APPENDIX 1 (cont.)

5.5	Geological map : Oil Exploration Directorate : Malta 1993		
5.8	Geological map : Oil Exploration Directorate : Malta 1993		
5.9	Hodges	1970	p.86
5.15	Heizer	1966	p.823
5.16	Heizer	1966	p.825
5.17	Heizer	1966	p.826
5.18	Hutton	1922	Plate XVI
5.19	Erasmus	1965	Fig. 2
5.21	Abrams	1984 a	p.169
9.1	Renfrew	1973 a	Fig. 33

APPENDIX 2

Author's review of literature pertaining to the organisation of pre-state societies as the comparative basis for Chapter 9, and fully listed in the bibliography:

Adams 1975

Arnold 1996

Barth 1967

Bellwood 1987

Braun & Plog 1982

Carneiro 1981

Chapman 1985, 1990

Chase & Chase 1996

Cherry 1978, 1983

Clark & Piggott 1965

Cohen & Service 1978

Creamer & Haas 1985

Drennan 1983

Earle 1985, 1987, 1991, 1997

Feinman & Neitzel 1984

Flannery 1972

Fox, Cook, Chase & Chase 1996

Fried 1978

Friedman 1982

Goldenweiser 1936

Johnson & Earle 1987

Kirch 1989, 1990

Knapp 1990

Leach 1983

Level 1979

McCall 1979

McGuire 1983

Malinowski 1932

Orme 1981

Phillips 1973

Renfrew 1973 c, 1979 b

Renfrew & Cooke 1979

Sahlins 1963

Sanders & Price 1968

Terrell 1986

Webster D. 1976

Webster G.S. 1996

Willey 1974

Yoffee 1993

APPENDIX 3

Author's review of literature pertaining to prehistoric Maltese Society's structure, Chapter 2, and fully listed in the bibliography.

Biaggi	1986
Bonanno	1986, 1990 b, 1995, 1996
Bonanno, Gouder, Malone & Stoddart	1990
Brea	1960
Evans	1959, 1971, 1973, 1977, 1984, 1996
Malone, Bonanno, Gouder, Stoddart & Trump	1993
Malone, Stoddart, Bonanno, Gouder & Trump	1995
Malone & Stoddart	1996
Renfrew	1973 a, 1973 b, 1974, 1979 b, 1986
Renfrew & Level	1979
Ridley	1976
Sorlini	1986
Stoddart, Bonanno, Gouder, Malone & Trump	1993
Trump	1962, 1966, 1976, 1981, 1990, 1995
Webster D.	1976
Webster G.S.	1996
Zammit	1930 a

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